0-12H VSR forecasting and nowcasting review and plan in CMA

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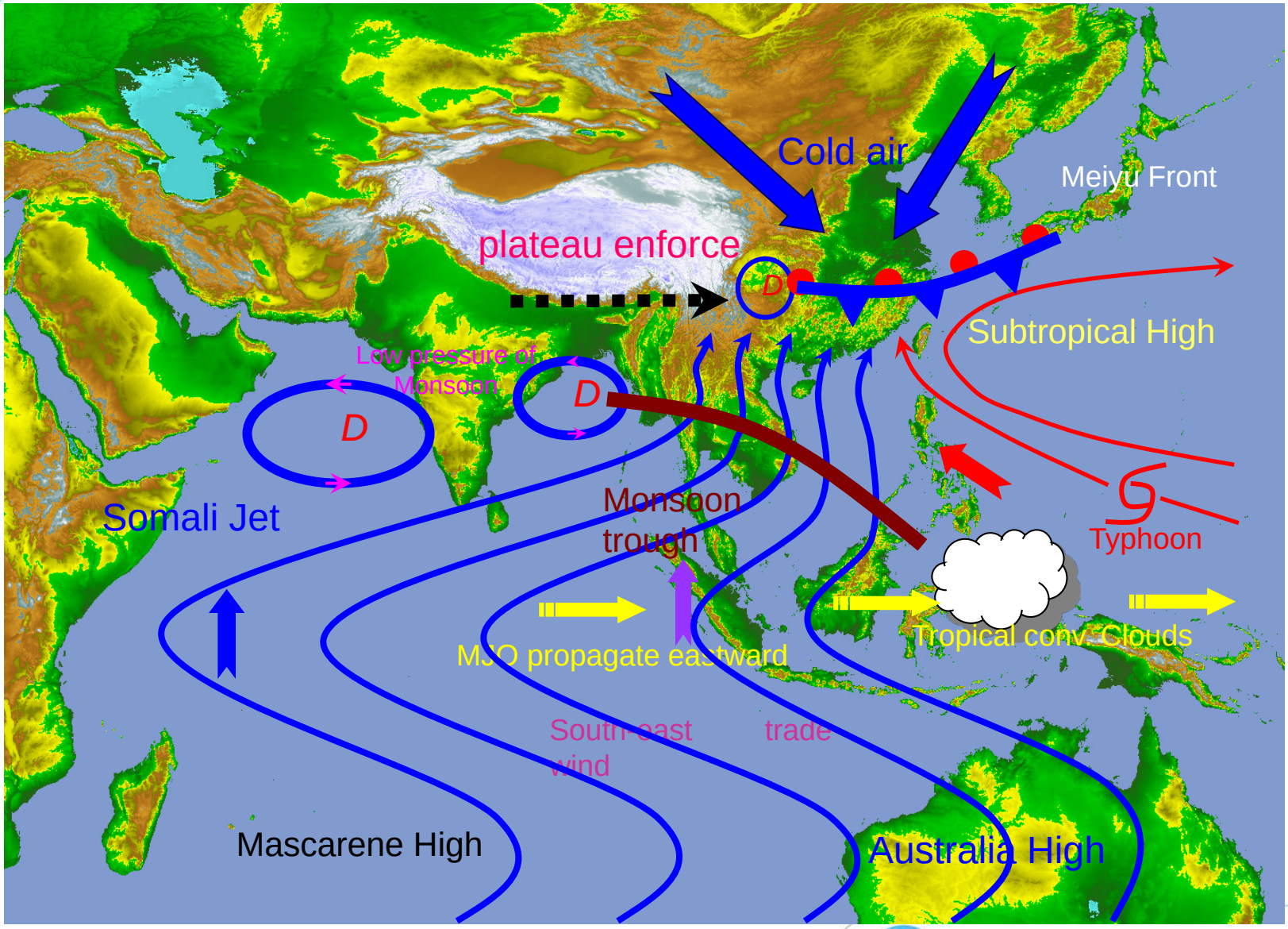
Jie Sheng, Yinjing Lin, Wenyuan Tang, Kanghui Zhou

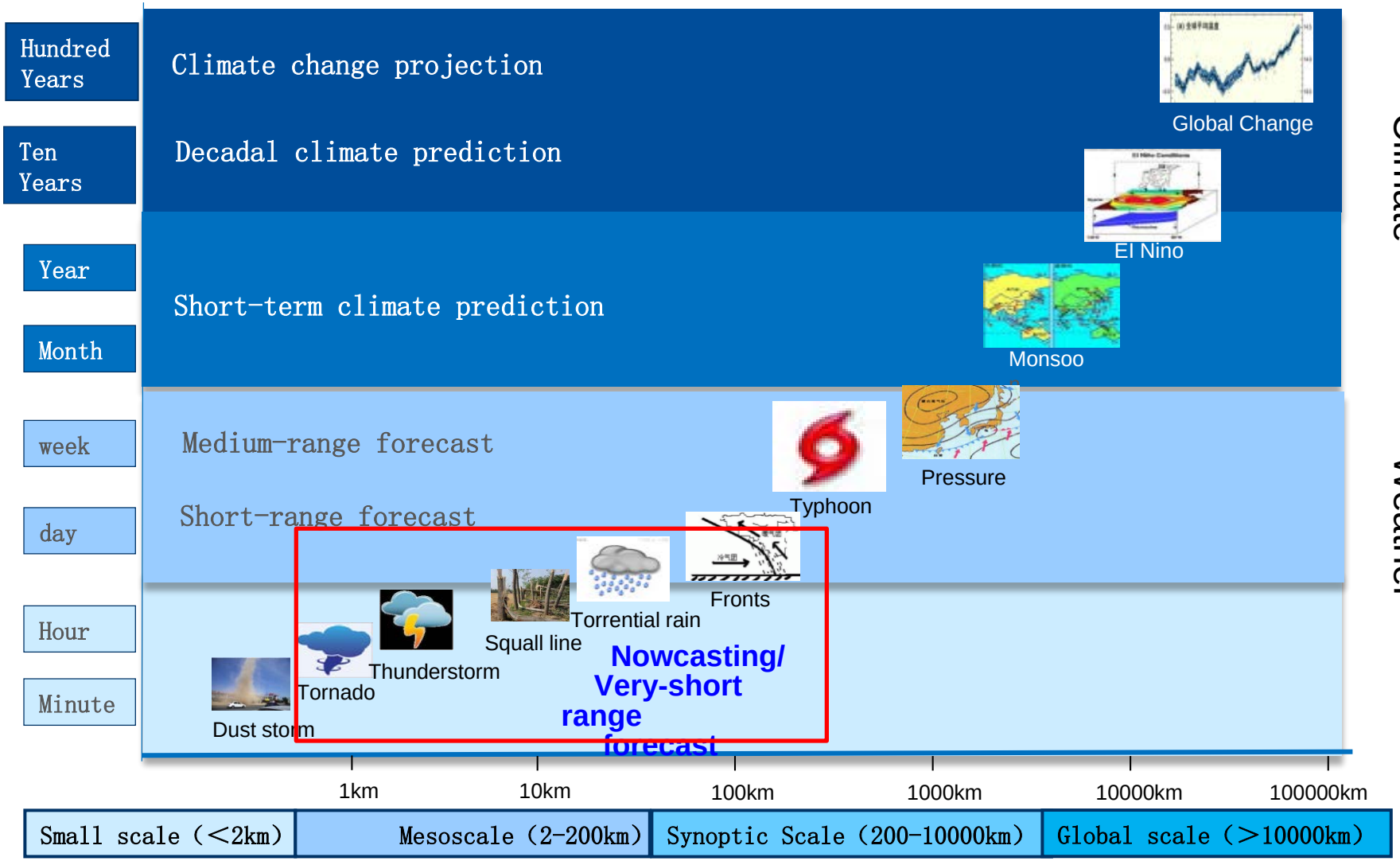
National Meteorological Center,
China Meteorological Administration

NATIONAL METEOROLOGICAL CENTER OF CMA



NATIONAL METEOROLOGICAL CENTER OF CMA

Weather and Climate Systems



NATIONAL METEOROLOGICAL CENTER OF CMA

Severe Convective Weather

- Hail ≥5 mm
- Thunderstorm gale≥ 17m/s
- Tornado
- Short-time rainstorm≥20mm/h

Squall-line

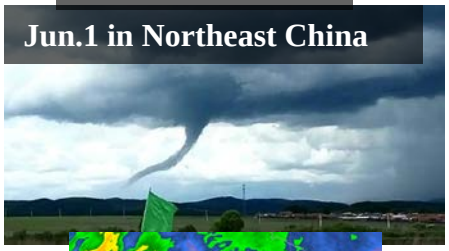
Gauntry crane collapse in Guangdong Apr.13

Hail

Haerbin Hail in Jun.12

Tornado

Jun.1 in Northeast China



Funing EF4 tornado in Jun.23

Short-time Rainstorm

North China in Jul.19-20

138.5mm/h（2300BJT Jul.19)

Contents

- Severe convective weather characteristics and its operational forecasting in CMA
- 0-2h Nowcasting
- **2-12h Very-short-range forecast**
- Future Prospects

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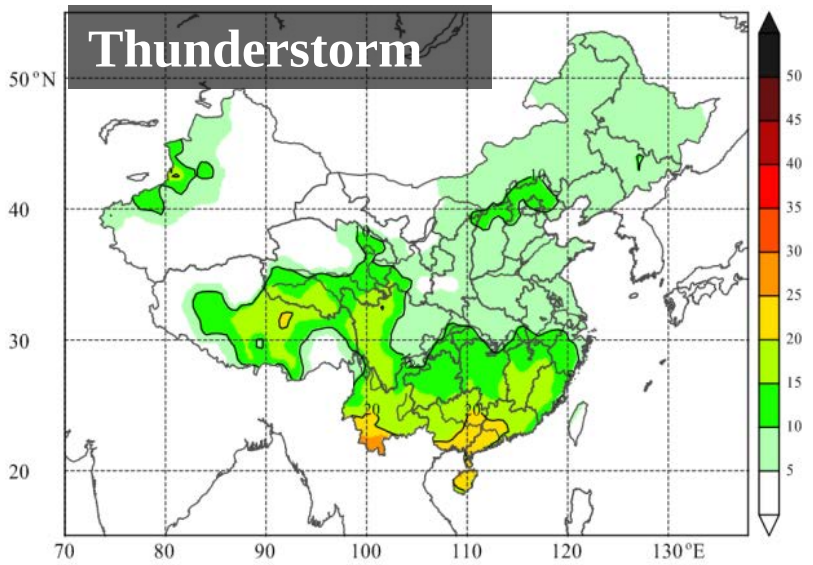
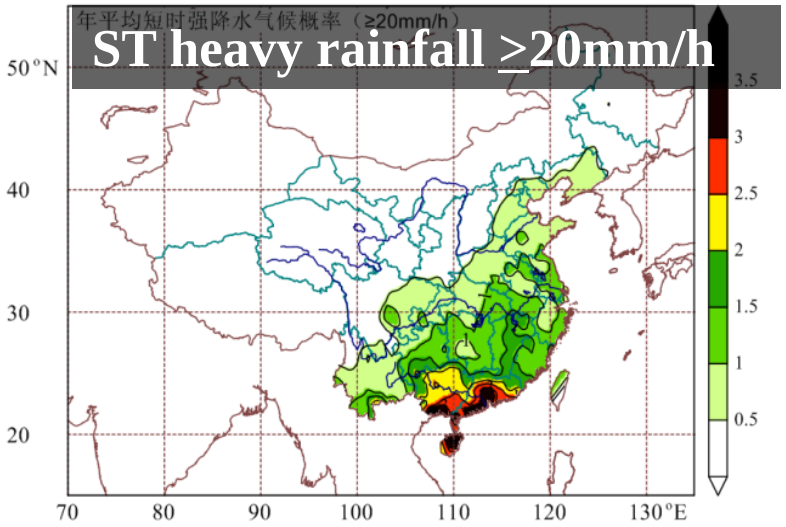
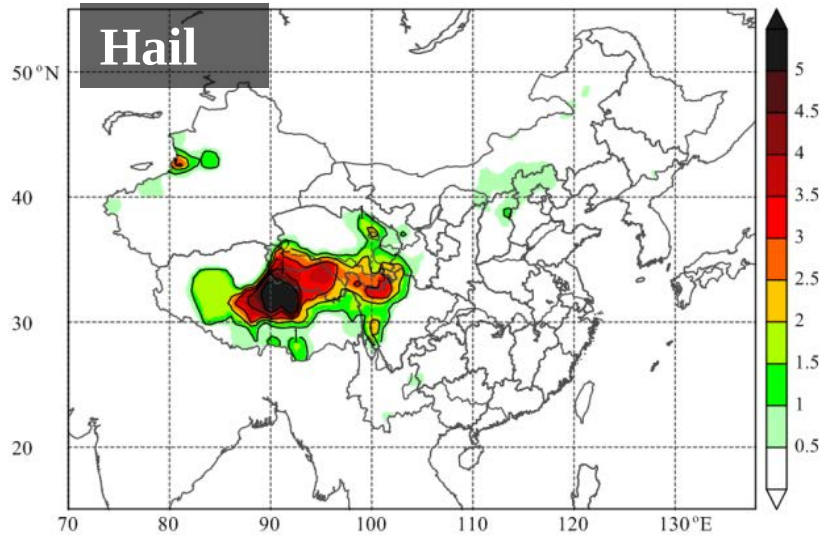
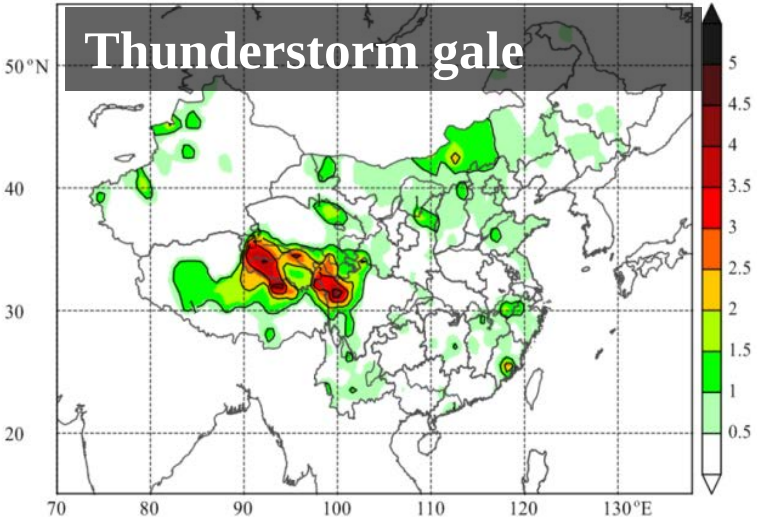
- **2-12h Very-short-range forecast**
- Future Prospects

1981-2010 annual frequency of severe convective weather

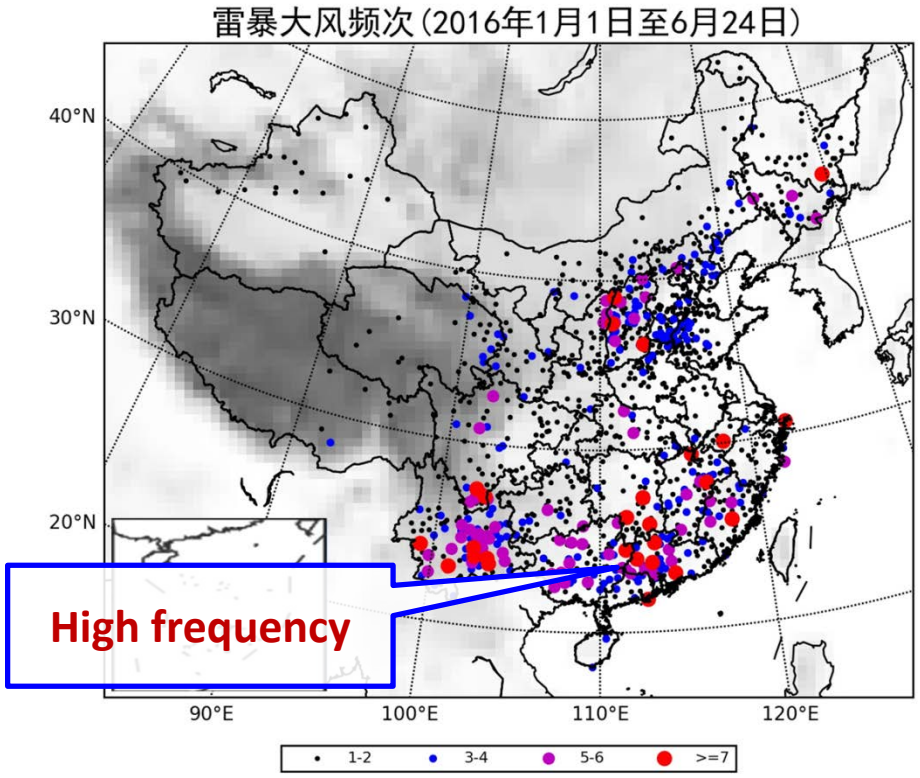




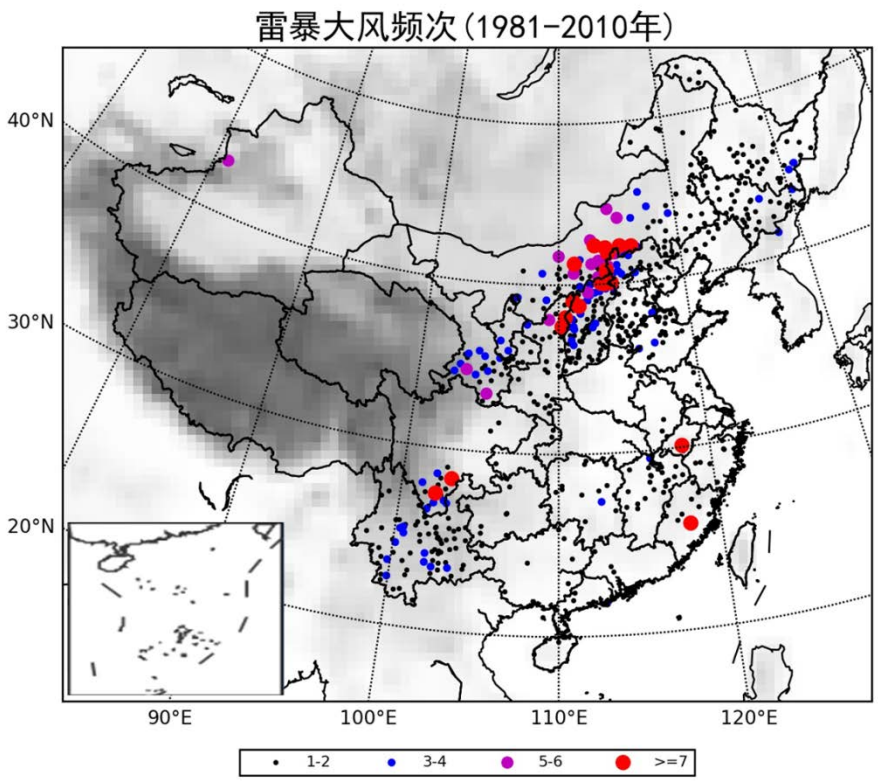




The high wind in 2016 vs 1981-2010

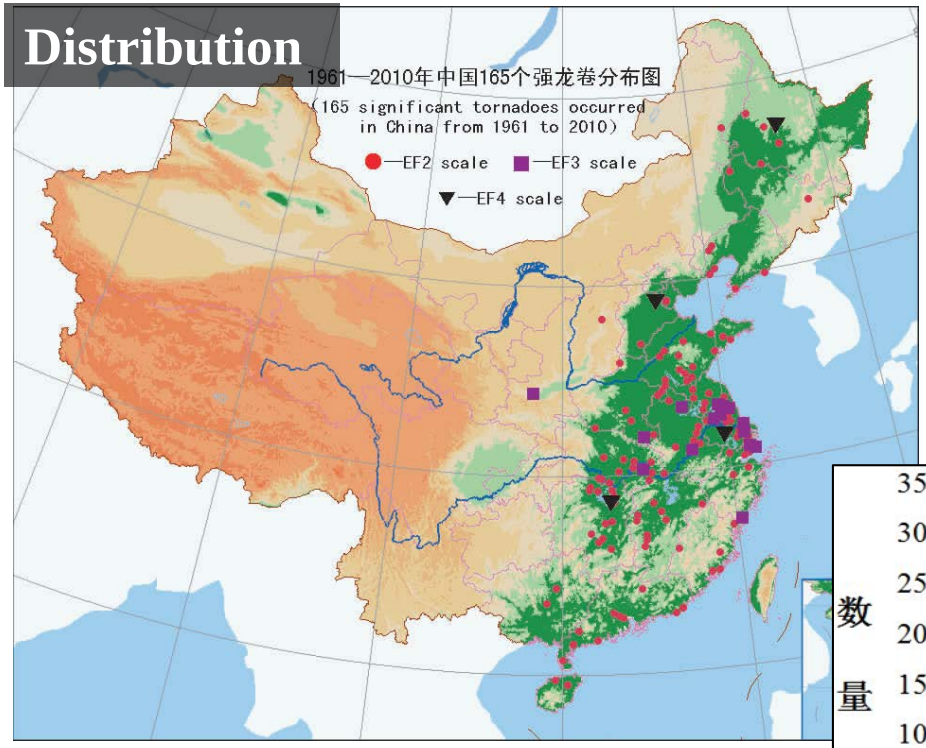


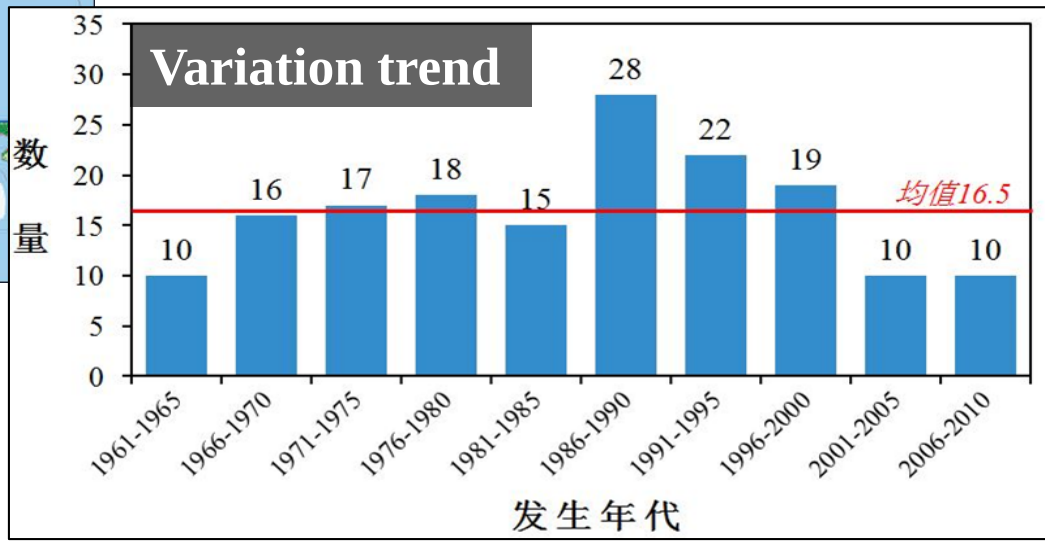
Jan.1-Jun.24 2016



Jan.1-Jun.24 1981-2010

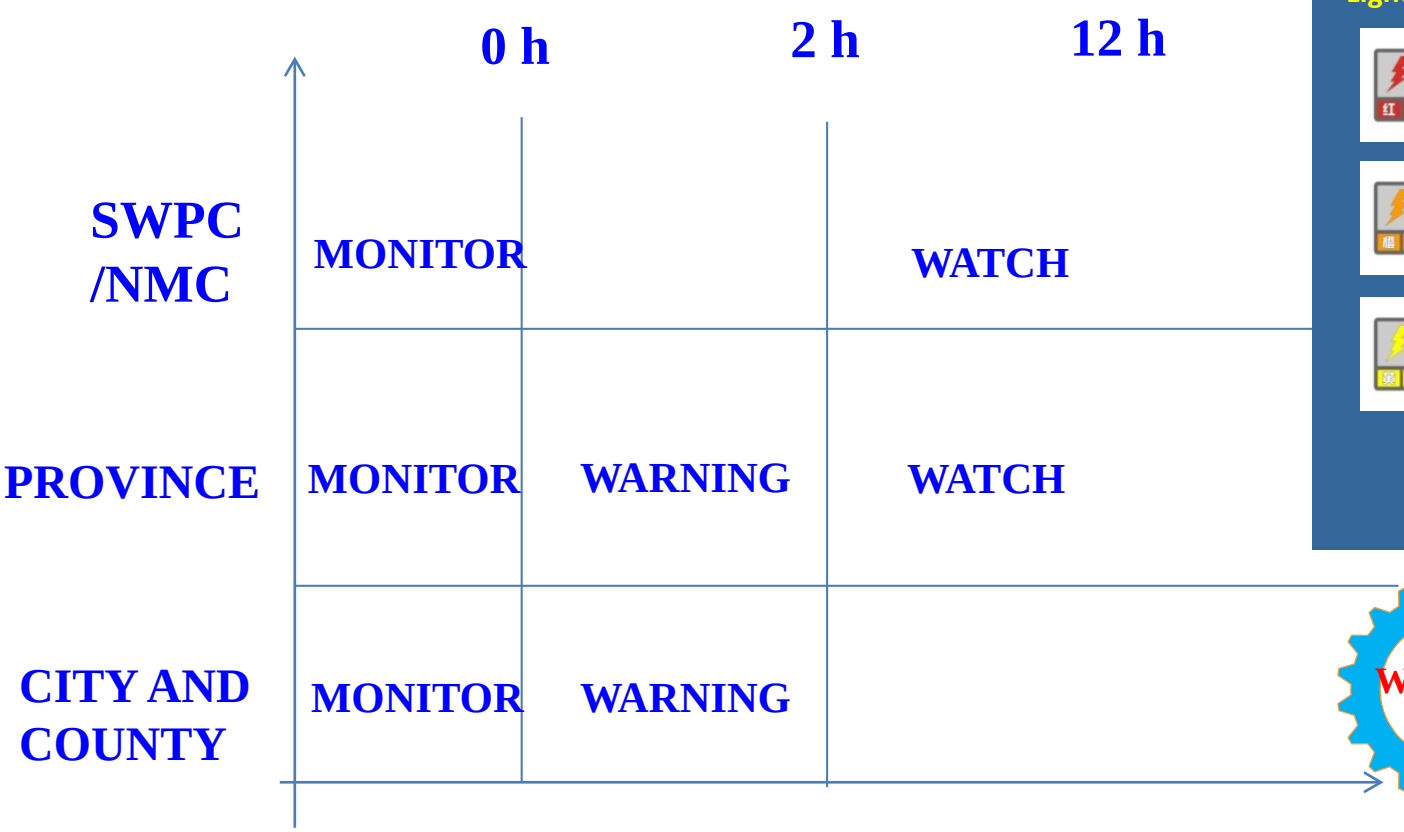
Distribution and variation trend of EF2 tornados and above in 1961-2010



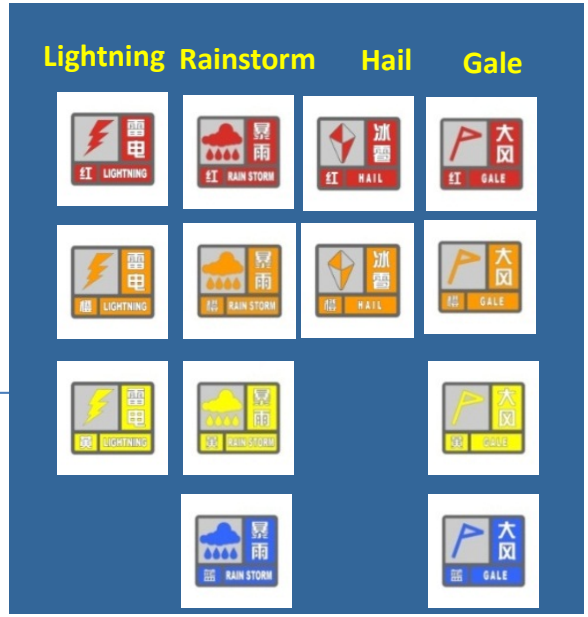


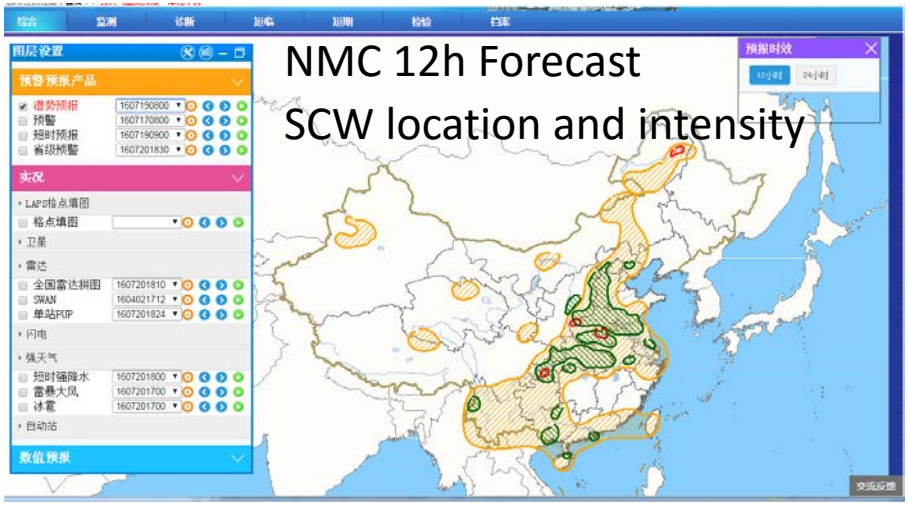
From Wenjie Fan and Xiaoding Yu， 2015）

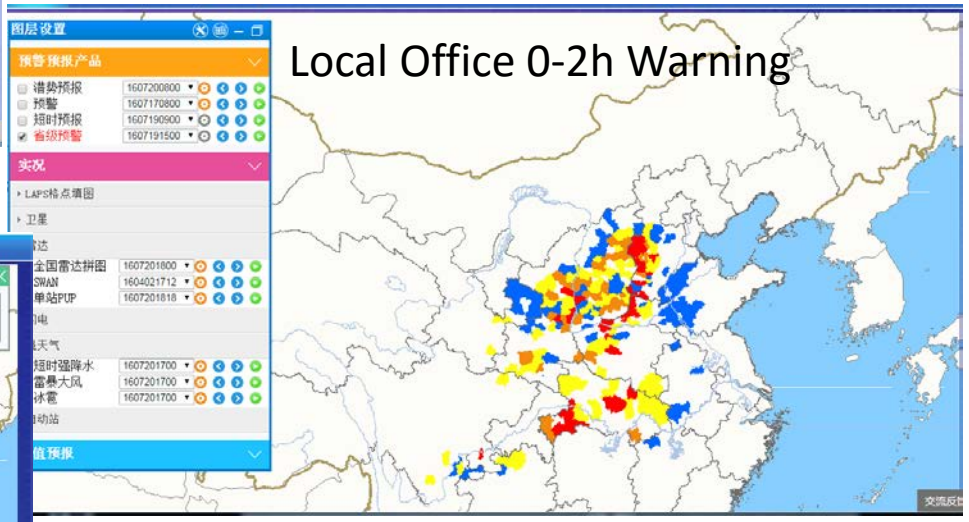
Operational responsibility in CMA

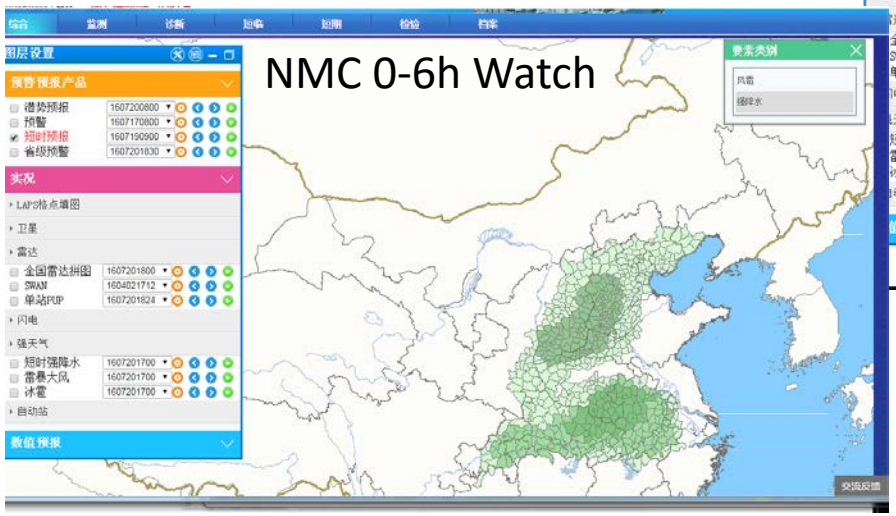


Warning signals




NMC 12h Forecast
SCW location and intensity


Local Office 0-2h Warning


NMC 0-6h Watch

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- Severe convective weather characteristics and its operational forecasting in CMA
- 0-2h Nowcasting
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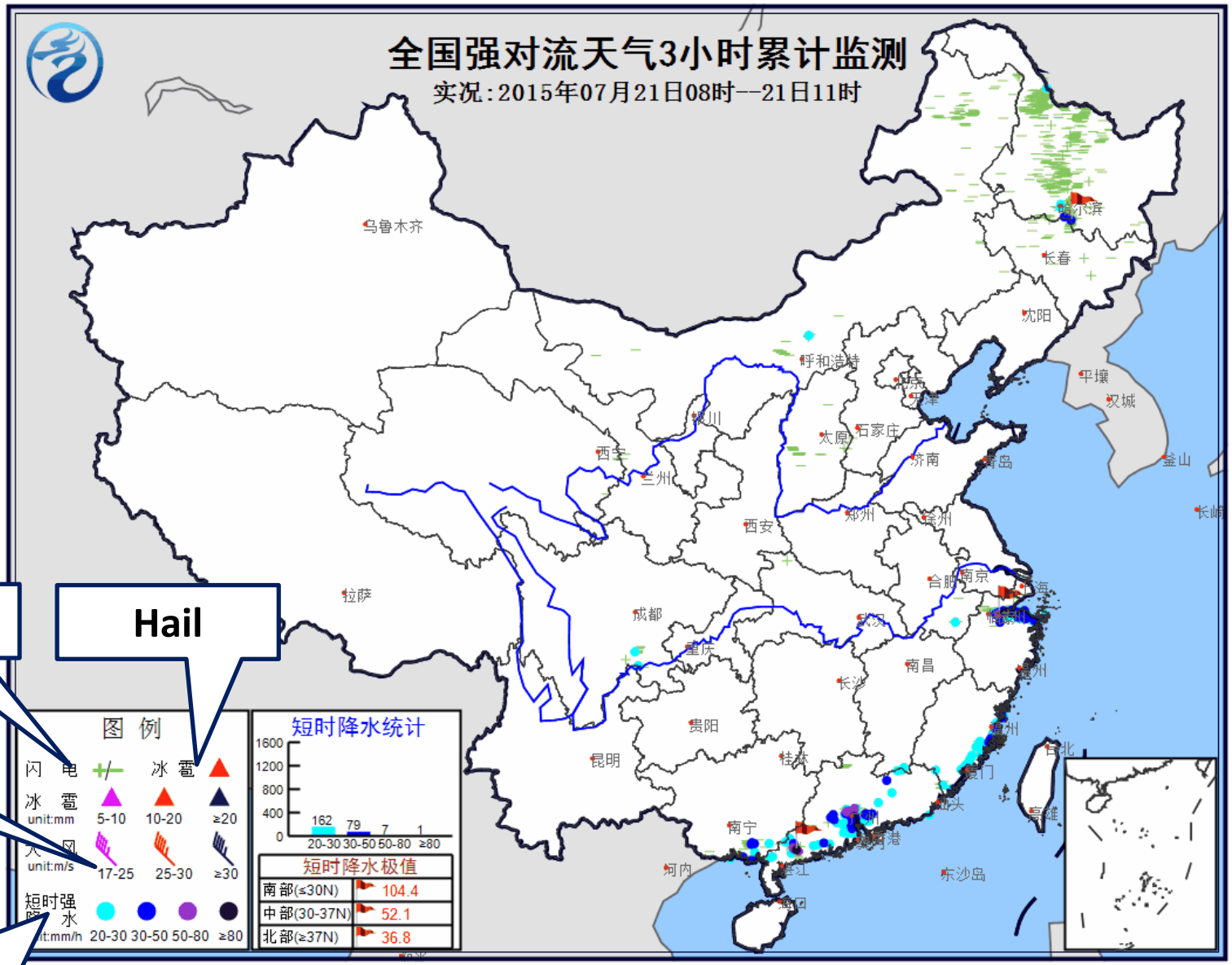
- Future Prospects

- In SWPC/NMC, the monitoring and Extrapolation techniques mainly based on satellite and lightning data
- In local office mainly based on the radar data

Severe Convective Weather monitor in NMC



Lightning

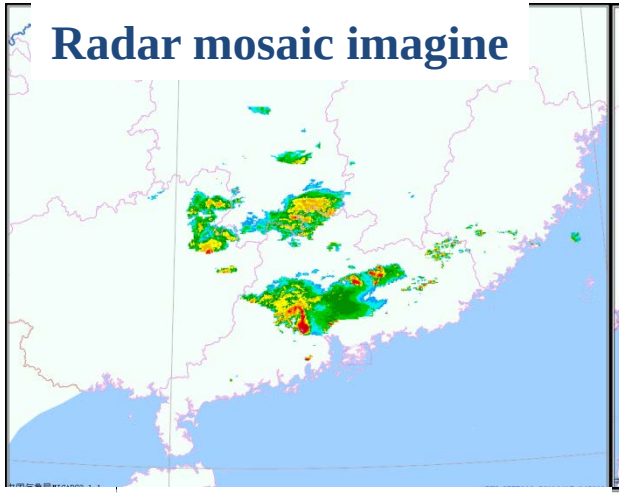
Hail

High Wind

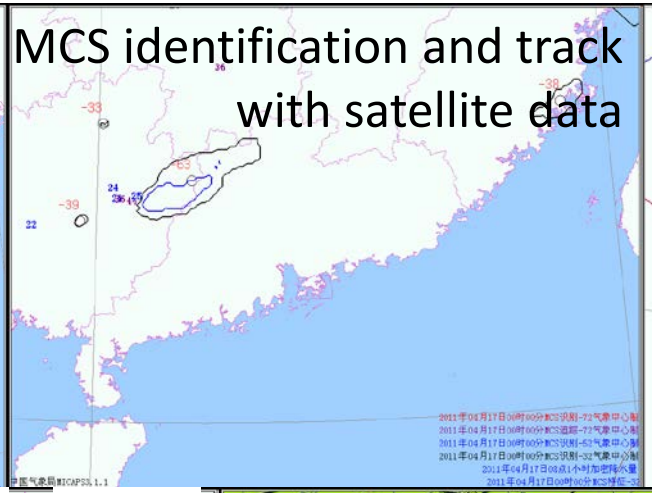
Short-time heavy rainfall

Multiple data applied in a severe convective weather events in South China

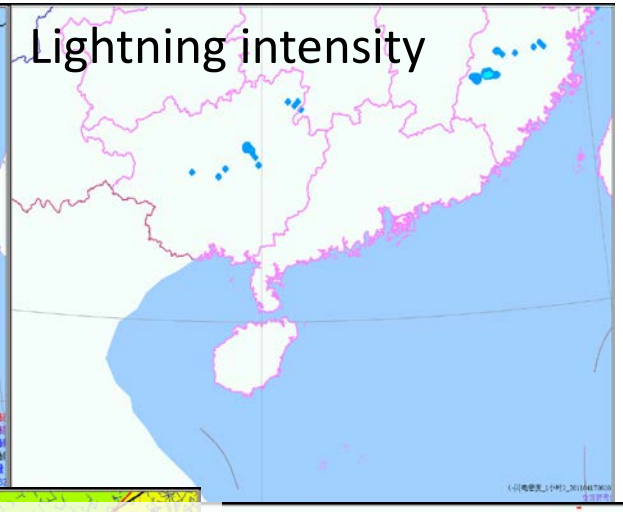
Radar mosaic imagine



MCS identification and track with satellite data



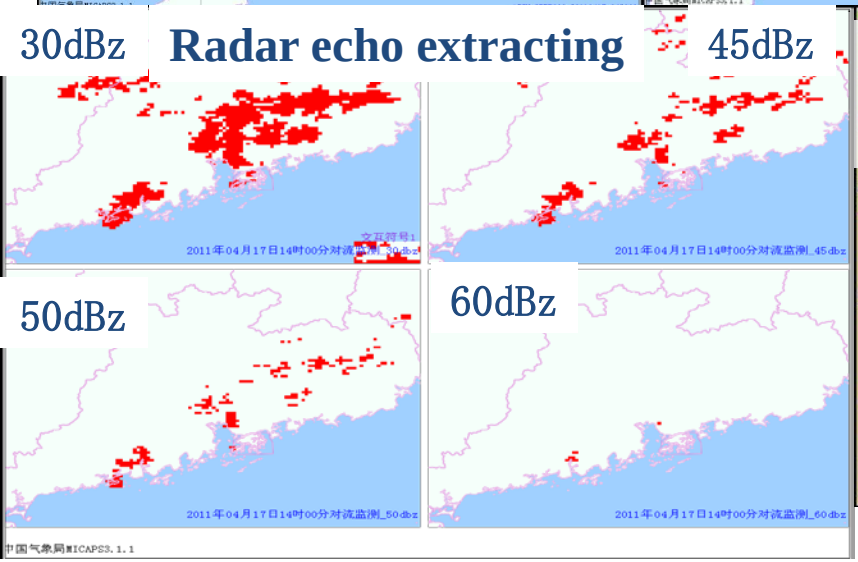
Lightning intensity



30dBz

Radar echo extracting

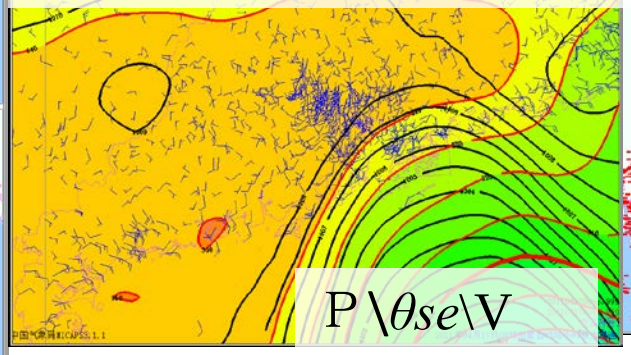
45dBz



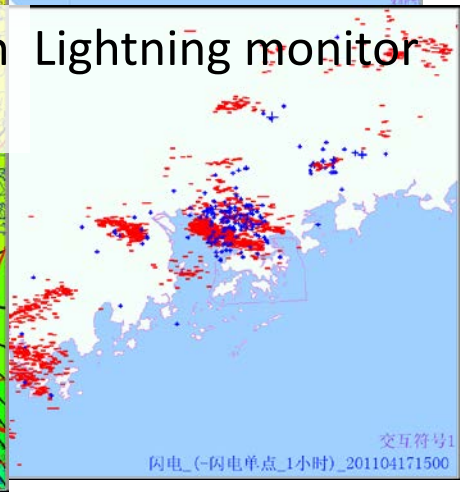
50dBz

60dBz

Objective analysis based on AWS data

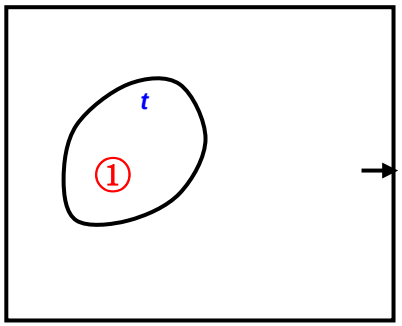


Lightning monitor

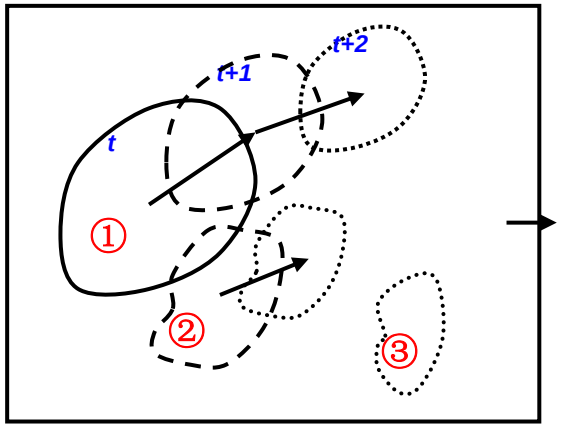


MCS recognition, track and extrapolation based on the FY satellites data

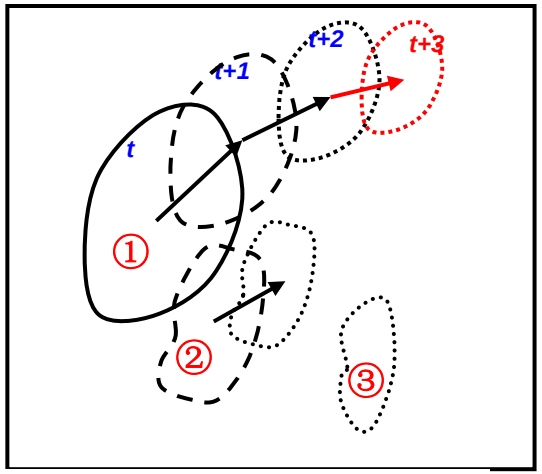
recognition

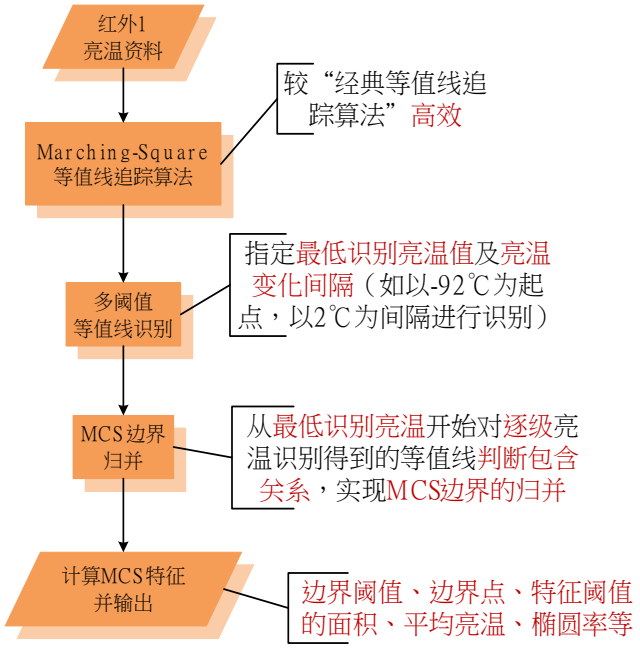


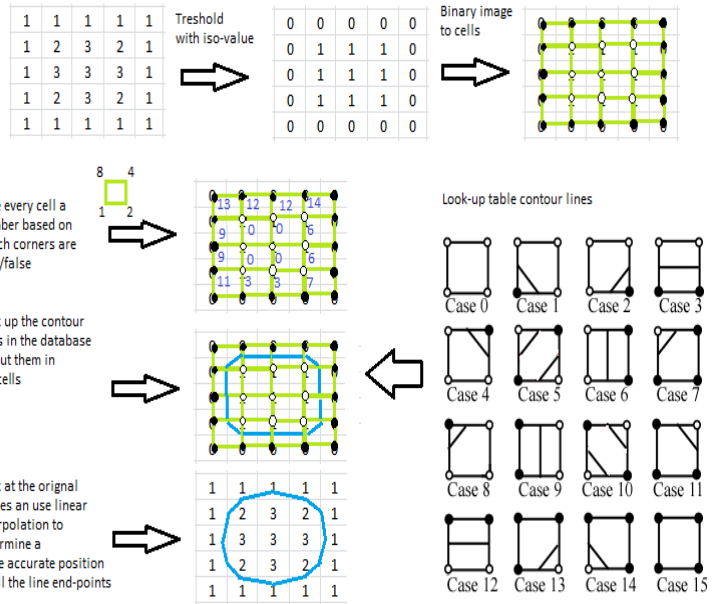
track



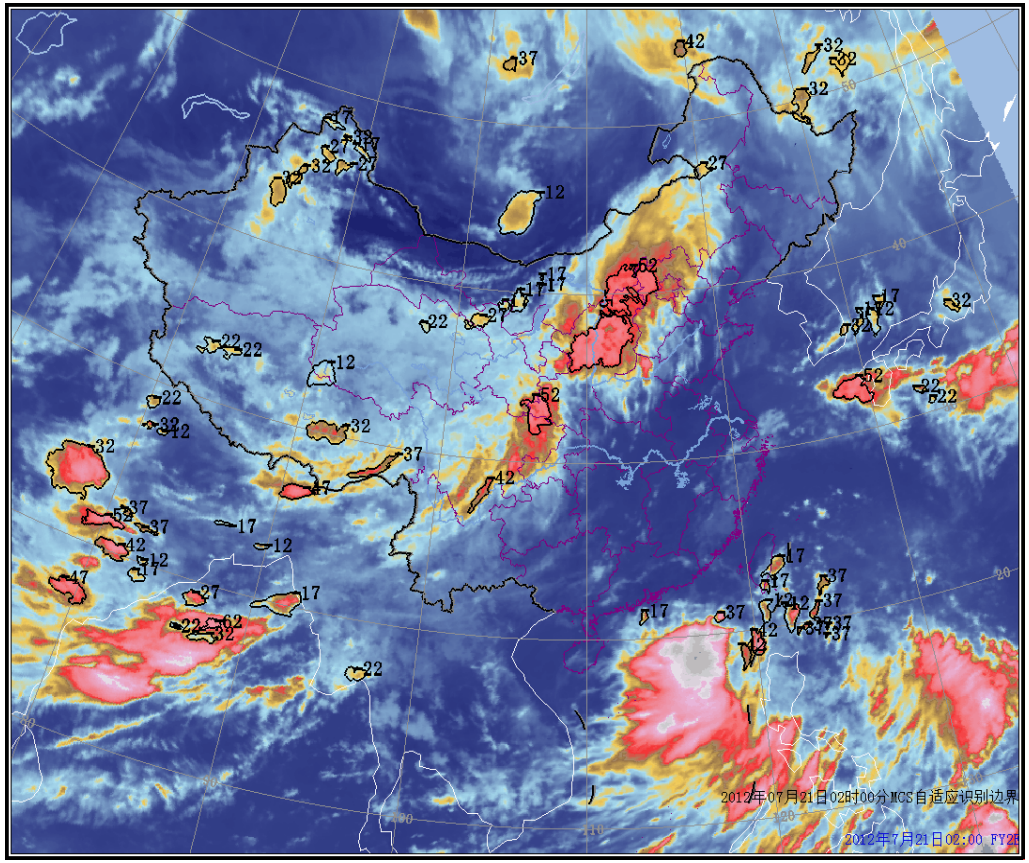
extrapolation

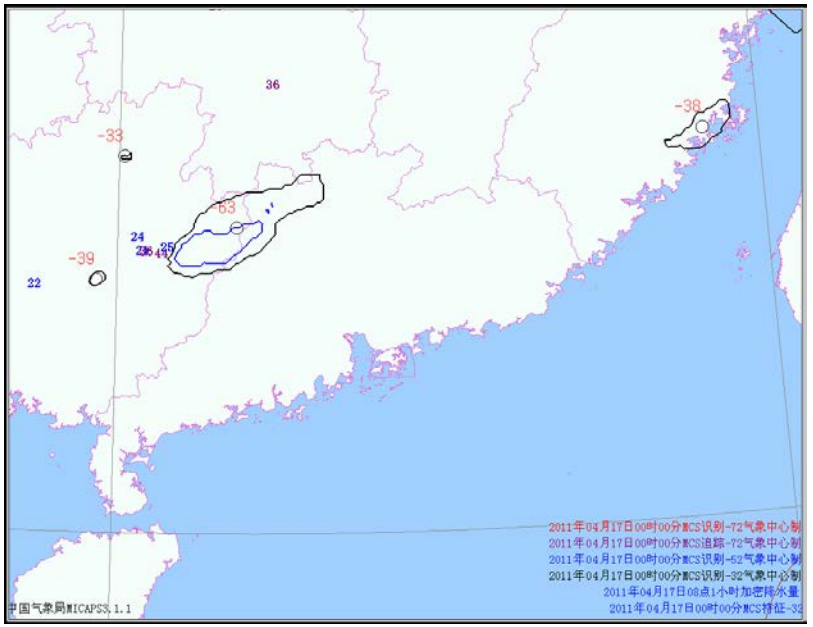


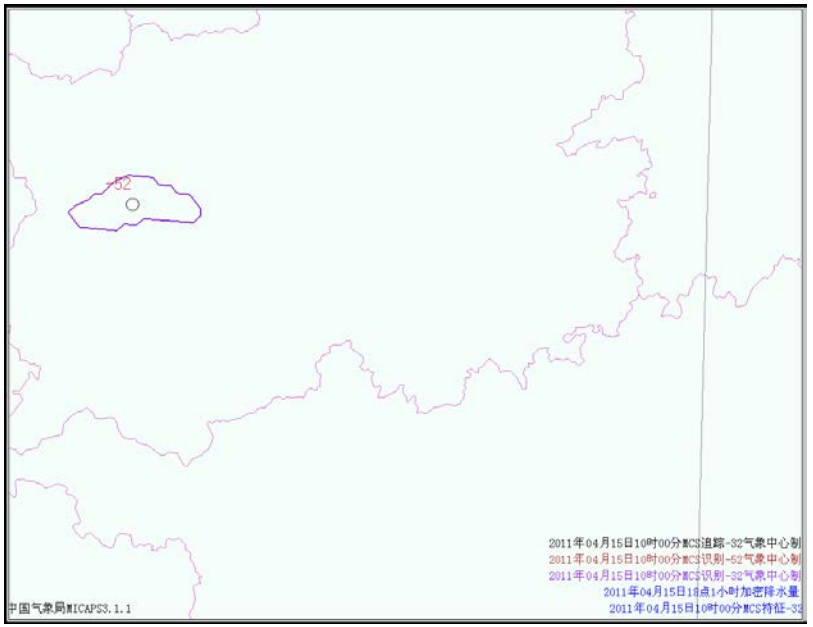




Recognition, track and extrapolation of the MCS based on the FY satellites data







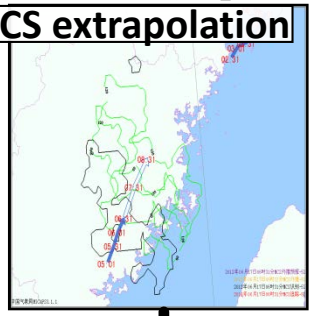
0-3h QPF based on the MCS extrapolation

MCSrecognition and extrapolation

+hourly precipitation monitor

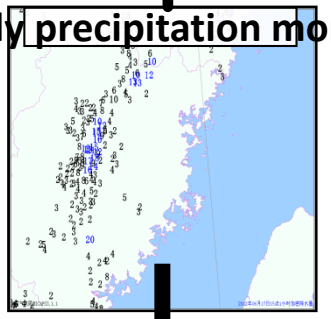
beginning at 1800BJT Jul.21 2012

MCS extrapolation

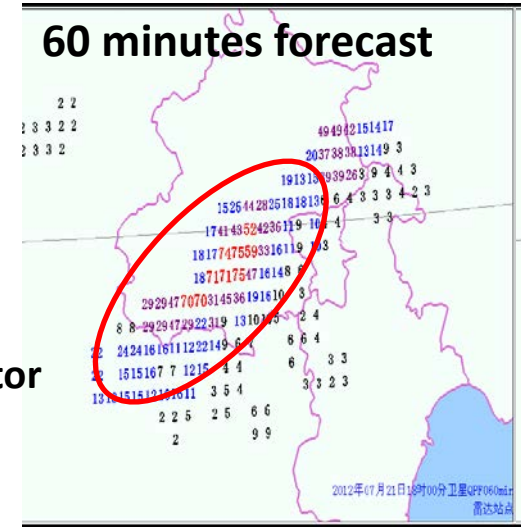


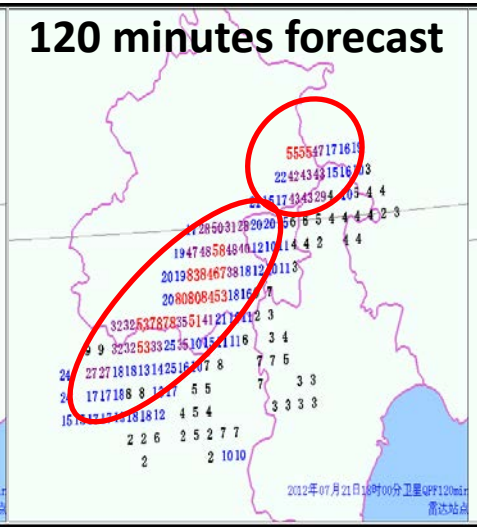
+

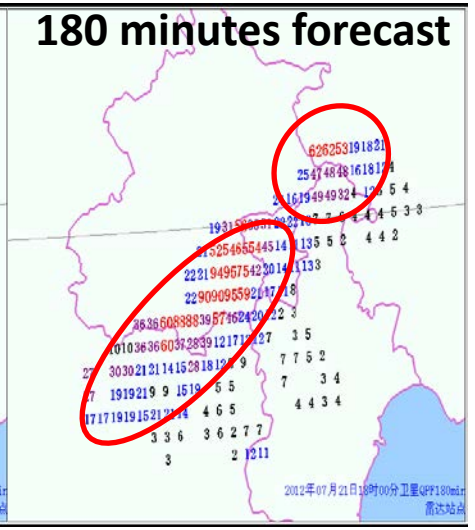
Hourly precipitation monitor

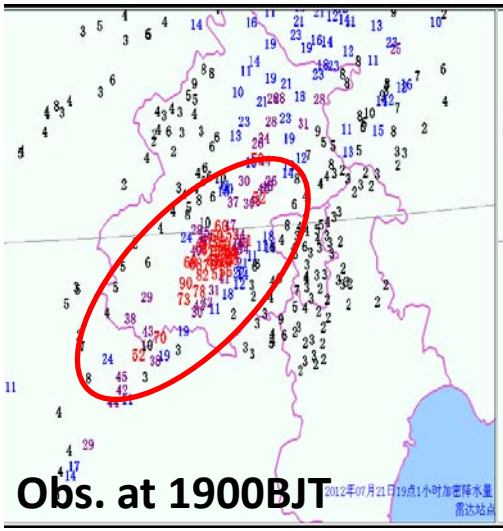


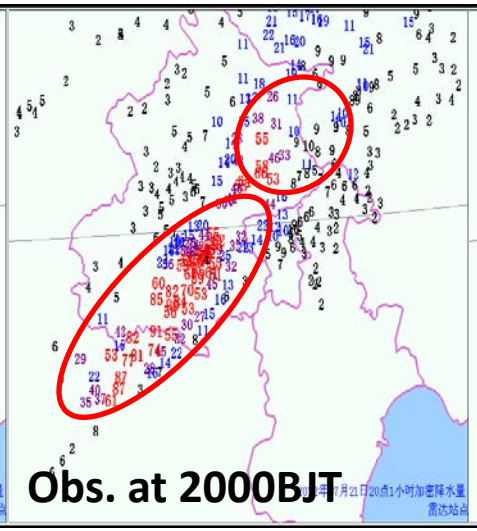
0-3h QPF

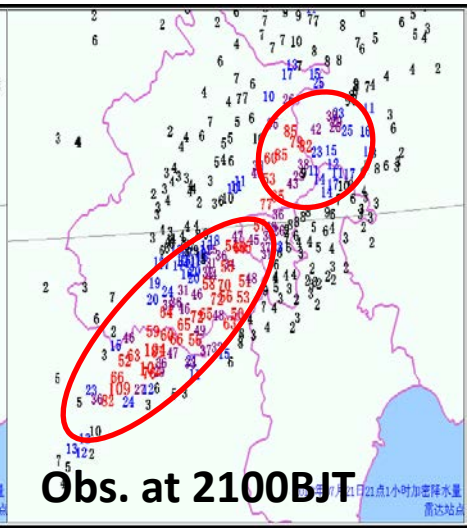








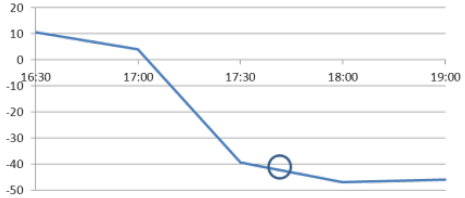




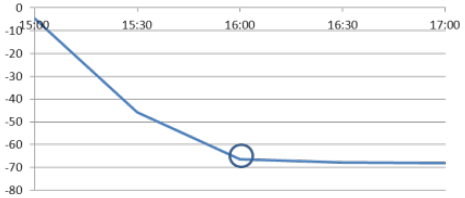
Quantity characteristics of Large –zone thunderstorm-gale-produced clouds

temporal evolution of averaged IR BT VS the timing of the gale

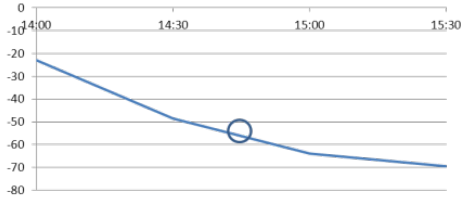
2007年7月22日安徽安庆红外亮温变化（雷暴大风时间：17:41）



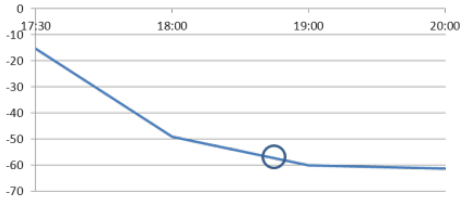
2007年7月22日江西湖口红外亮温变化（雷暴大风时间：16:02）



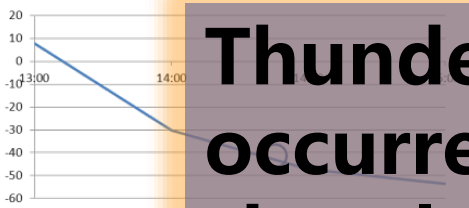
2007年7月22日江西德安红外亮温变化（雷暴大风时间：14:45）



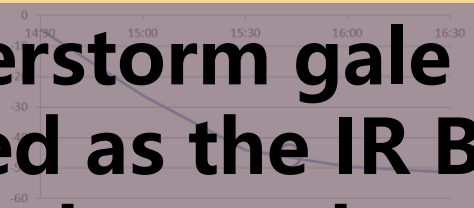
2007年7月22日安徽九华山红外亮温变化（雷暴大风时间：18:49）



2007年8月2日安徽定远红外亮温变化（雷暴大风时间：14:22）

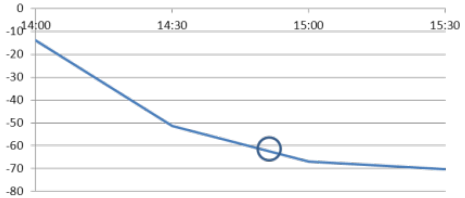


2007年8月2日安徽怀远红外亮温变化（雷暴大风时间：15:42）

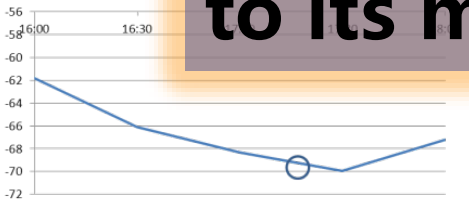


Thunderstorm gale likely occurred as the IR BT sharply dropped rather than to its minus

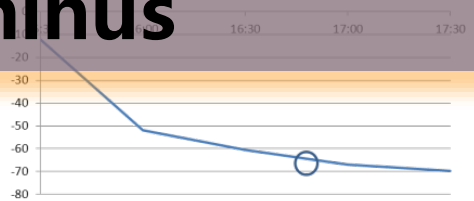
2007年8月2日安徽阜阳红外亮温变化（雷暴大风时间：14:50）



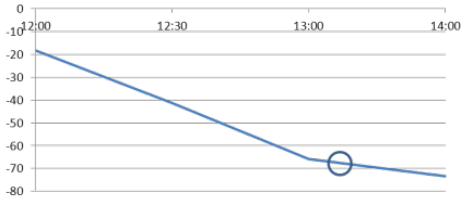
2007年8月2日安徽[illegible]红外亮温变化（雷暴[illegible]时间：17:18）



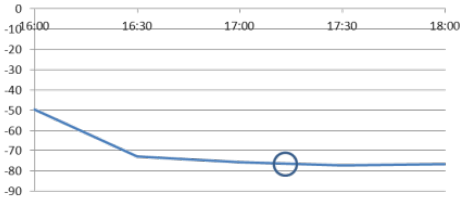
2007年8月2日安徽[illegible]红外亮温变化（雷暴大风时间：16:45）



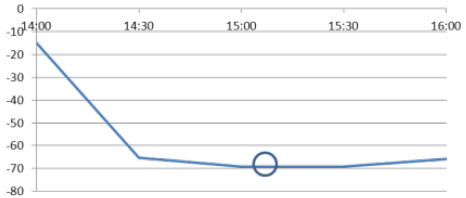
2007年8月3日江西武宁红外亮温变化（雷暴大风时间：13:22）



2007年8月3日江西丰城红外亮温变化（雷暴大风时间：17:12）

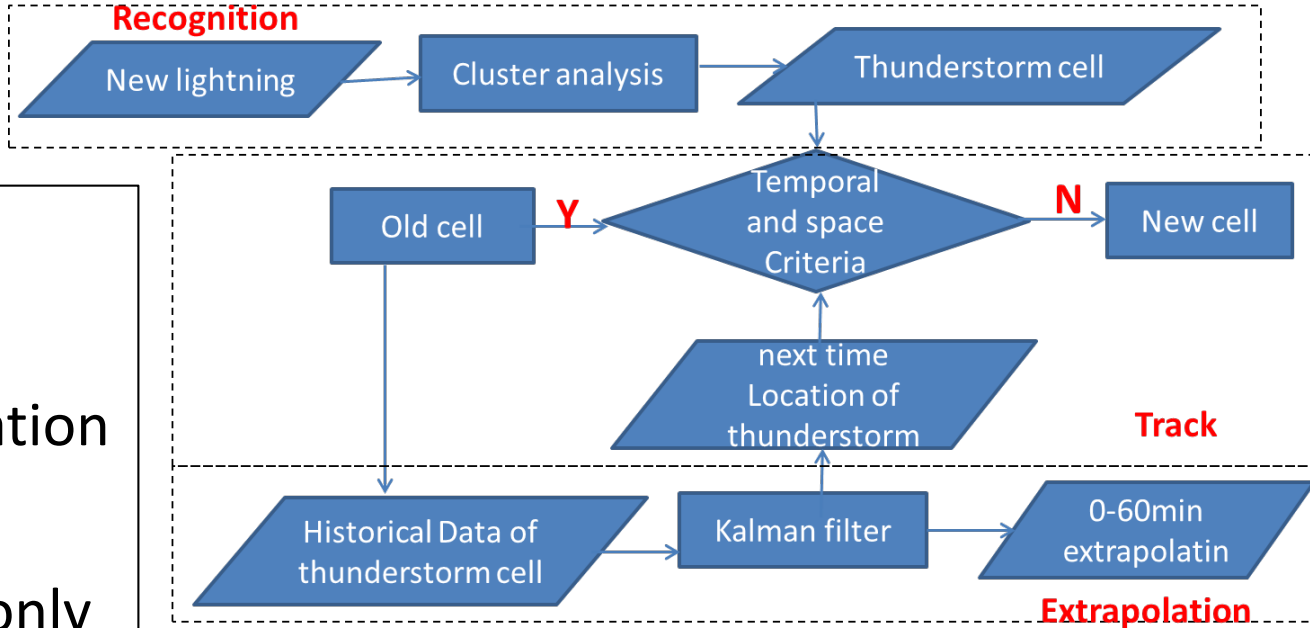


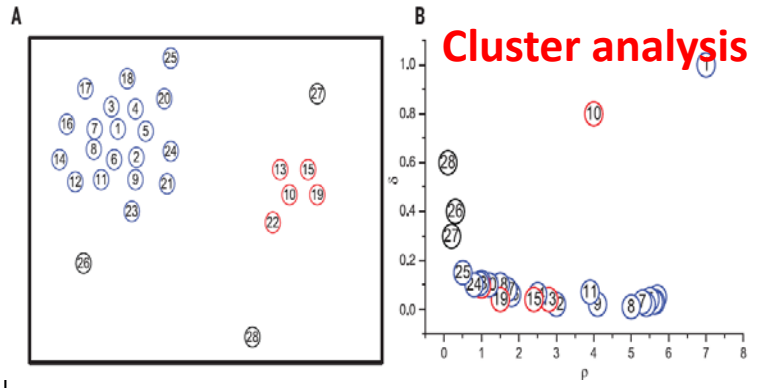
2007年8月3日江西九江红外亮温变化（雷暴大风时间：15:11）

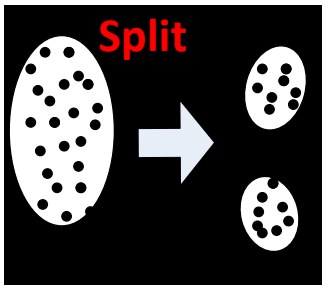


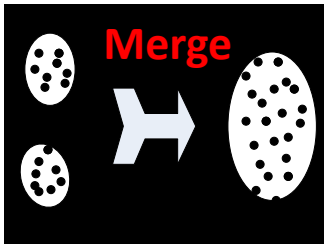
Thunderstorm cell recognition, track and Extrapolation based on the lightning data

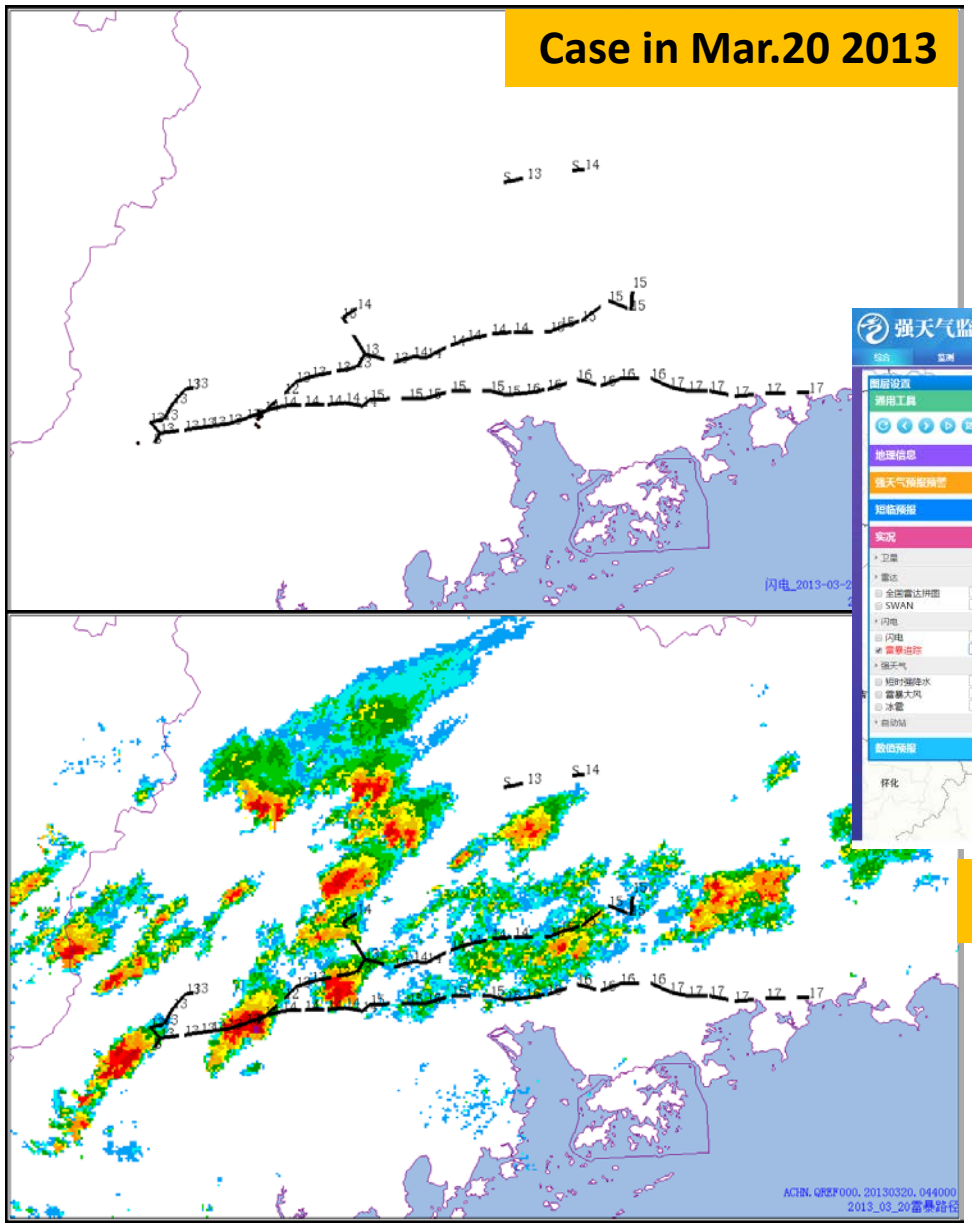
- Cell recognition by cluster analysis
- Track and extrapolation by Calman filter
- The algorithm not only recognizes and tracks thunderstorm cell, but also distinguishes the split and merge of thunderstorm.

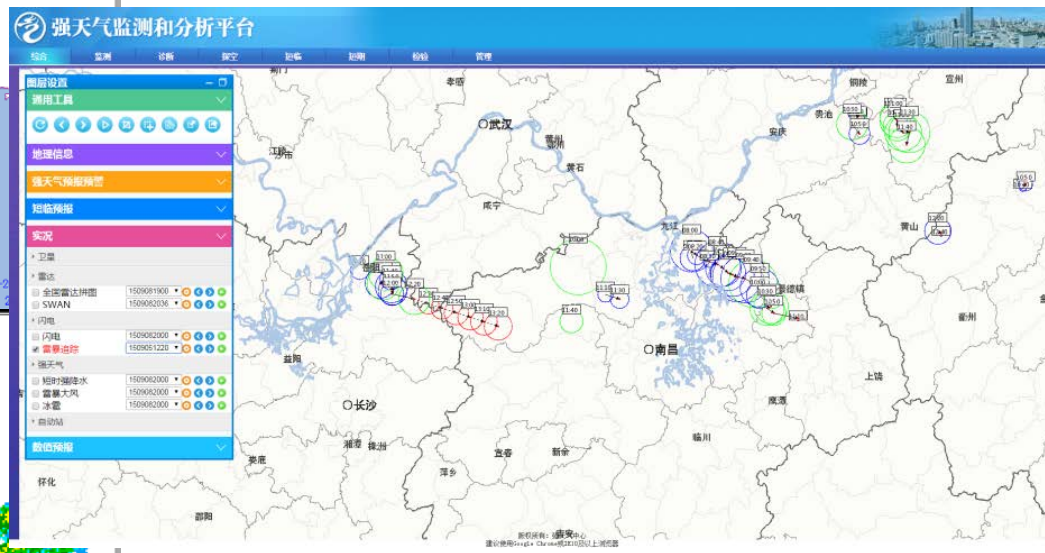








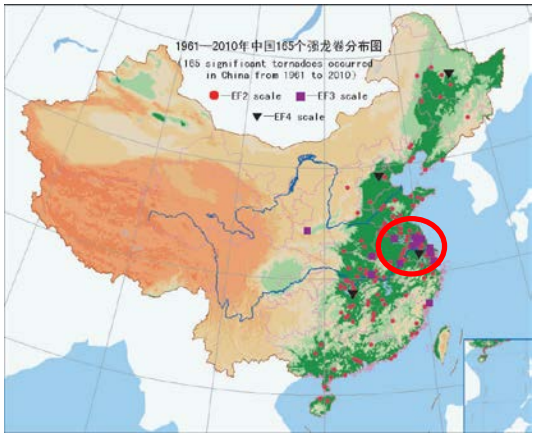




Integrated in SWPC operation platform

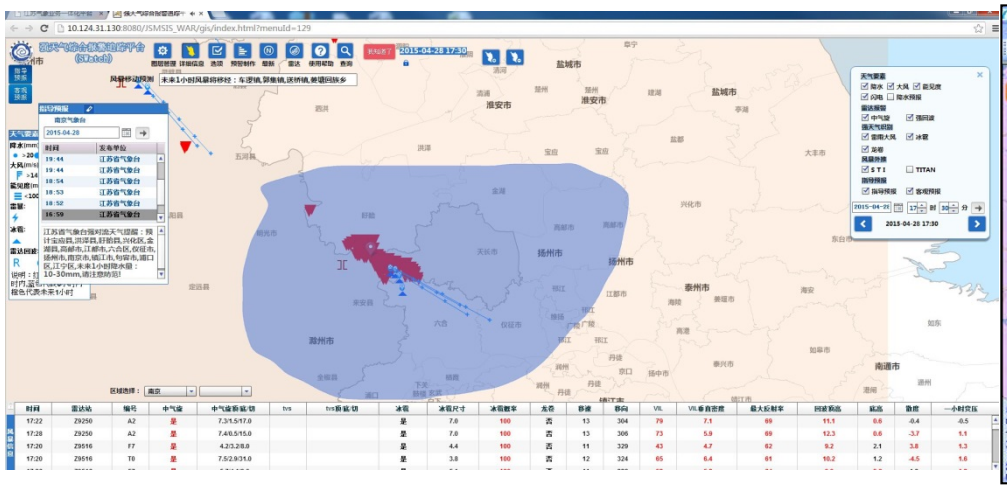
Tornado recognition and automatic warning in Jiangsu

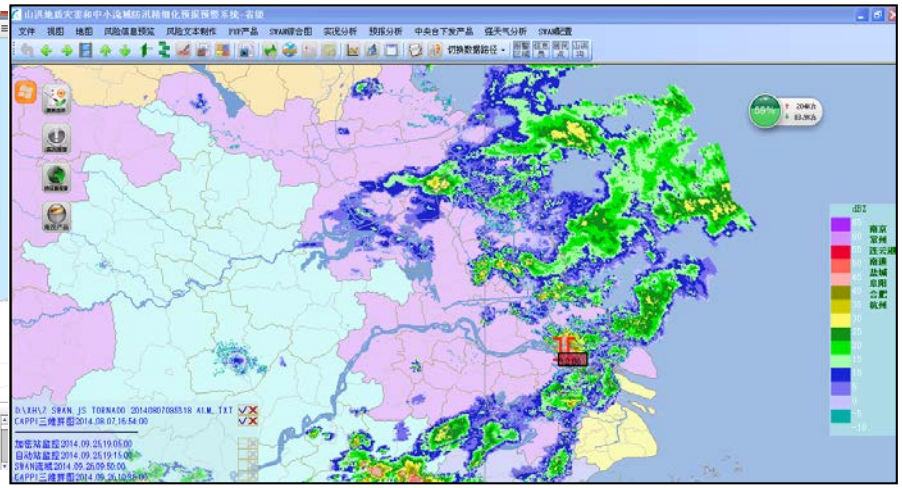
- Improved the Mesocyclone recognition algorithm Used in WSR-98D radar
- Decreased FAR by diagnosing the intensity, bottom height and wind shear of a mesocyclone
- Decreased FAR by pattern recognition



	TVS		MC
HIT	38%		61%
FAR	16	PUP 24	/
Total Num. by improved algorithm	40		71
Num. by PUP	47		168

Tornado recognition and automatic warning in Jiangsu

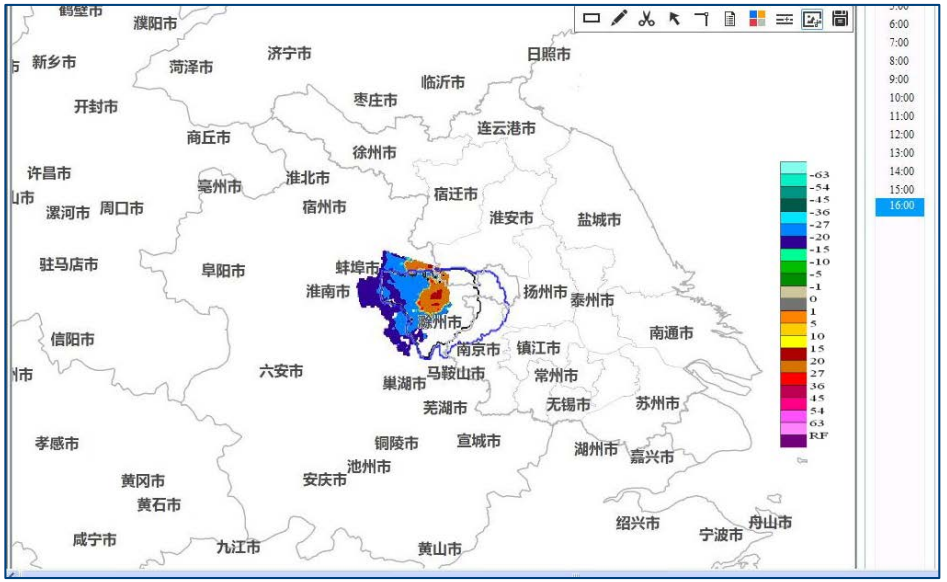




- Integrated in SWATCH which is the operation platform of Jiangsu province bureau
- Valid tornado-detected distance associated with typhoon and westerlies is 60km and 100km
- A weak tornado was recognized from the mixed echo nearby Nantong at 1653BJT Aug.7 2014
- Funing EF4 Tornado was recognized ahead of ~15 min. in Jun.23 2016

--- Yuanyuan Zheng 2016

High wind recognition by radar radial velocity at 0.5 elevation angles



- Used only in the area within 100km from the radar station
- Automatic warning used to value the risk of the electric power system

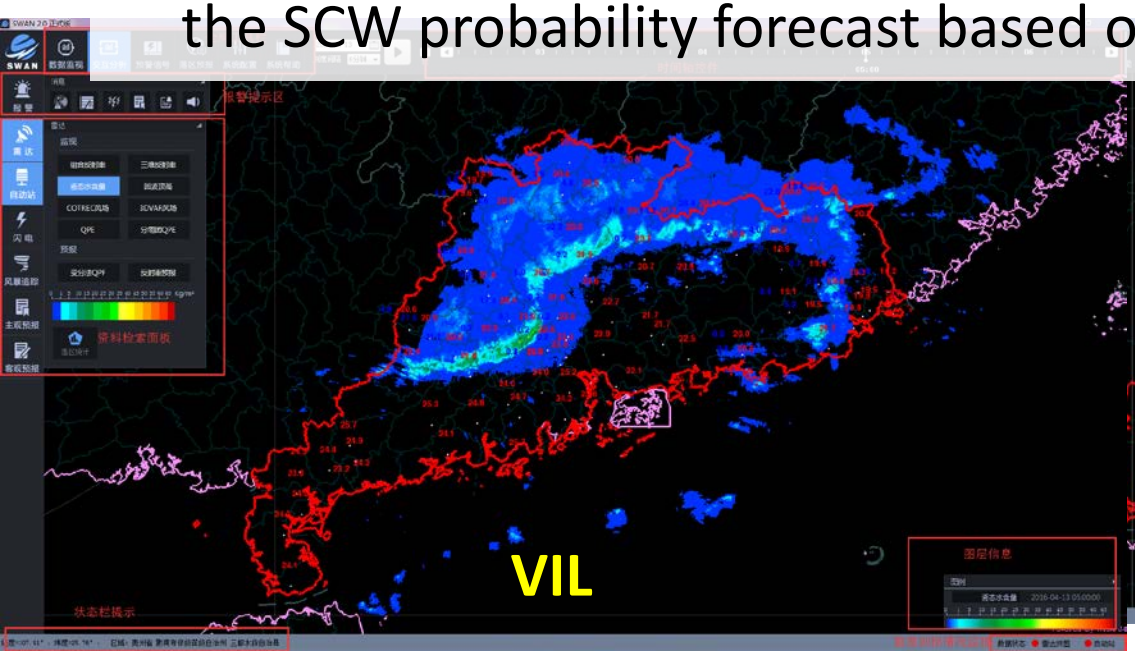
Severe Weather Automatic System(SWAN)

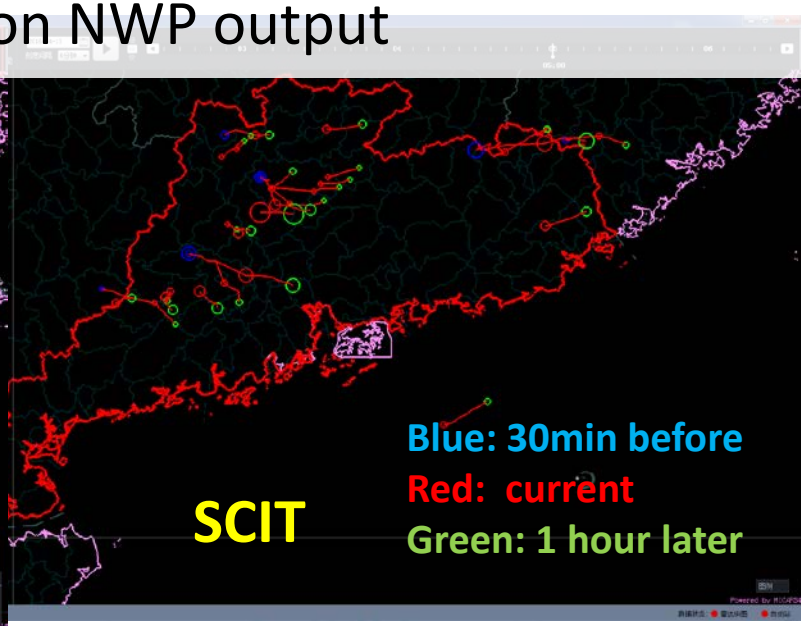
- **The main operation platform in CMA, used in many local offices**
- **Some updating in 2015**
- **Version2.0 replaced Version 1.6**
- **significant change in the aspects of algorithm, data resource and function**

✓ 3DVAR wind retrieval from Doppler radar

✓ rain cluster recognition by QPE

✓ enhanced very-short-range forecasting capability by integrated the SCW probability forecast based on NWP output





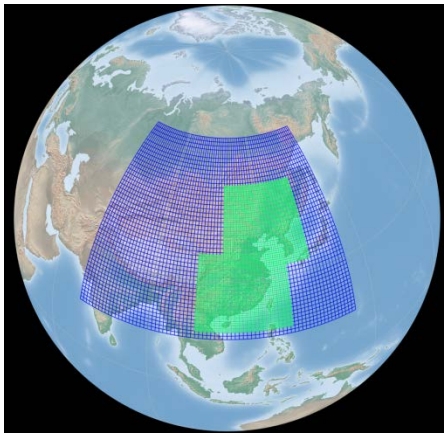
Contents

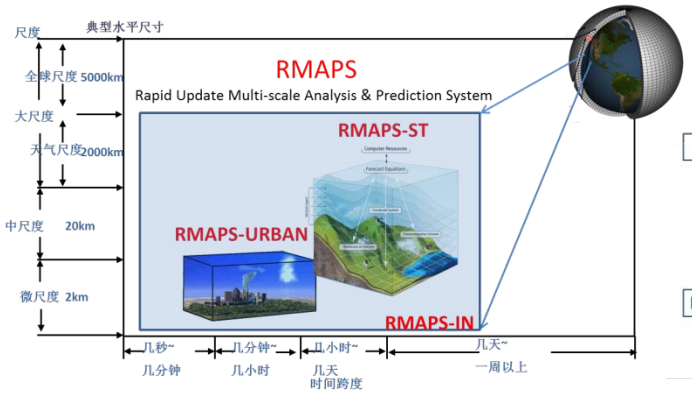
- Severe convective weather characteristics and its operational forecasting in CMA
- 0-2h Nowcasting
- **2-12h Very-short-range forecast**
- Future Prospects

High resolution models

- GRAPES-RAFS (10KM, 3h update, 30h valid time),and GRAPES-CR(3KM,12h update,48h valid time) in NPC/CMA
- RMAPS(9/3KM, 3h update) in Beijing Bureau
- SMB-WARMS(9/3KM,3h update) in Shanghai Bureau
- GRAPES-RAFS(9/3KM,3h update) in Guangdong Bureau

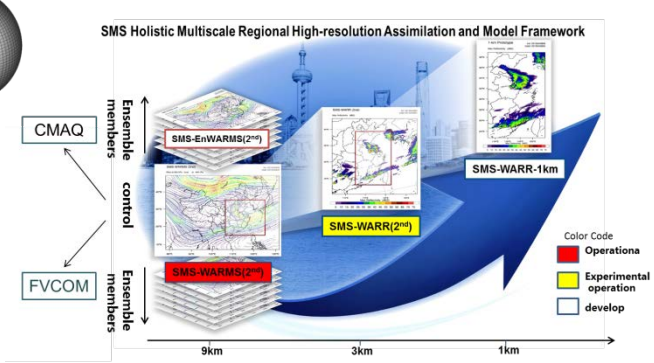
GRAPES-CR



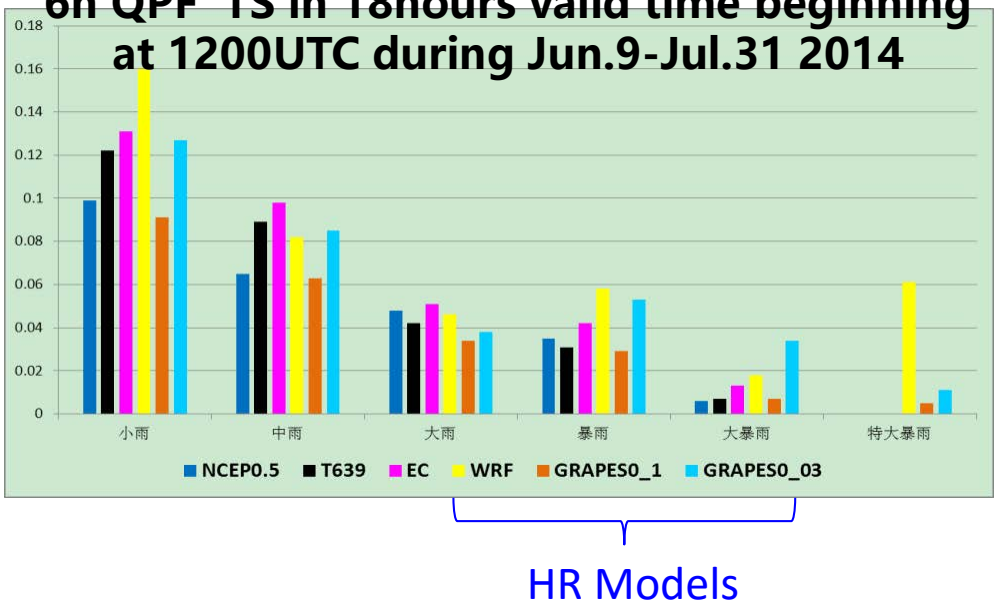


Nowcasting and VSR forecast, high resolution gridded products

SMB-WARMS



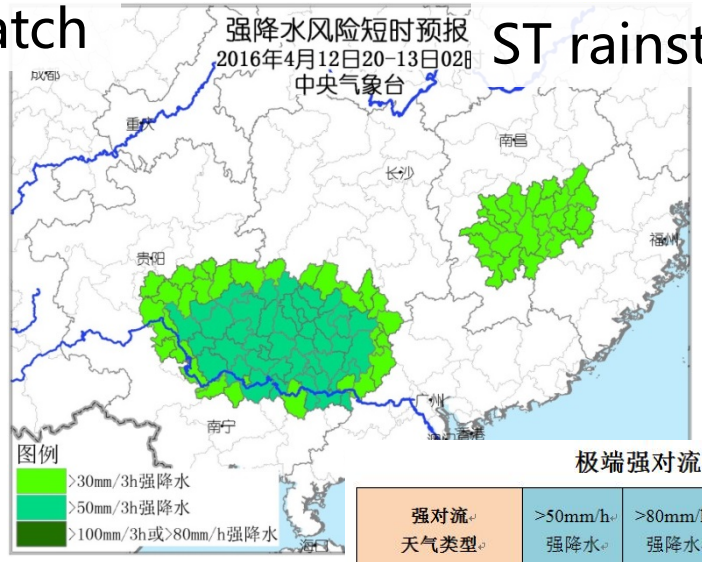
- Evaluated the high resolution model in warm season testbed during 2013-2014
- High resolution models would be useful in SCW forecast
- SWPC began to develop 2-12h forecast techniques based on high resolution models in 2015 and test the 2-6h operational watch in warm season of 2015 and 2016



SWPC experimental watch in 2015-2016 warm season

Thunderstorm gale and hail watch

ST rainstorm watch

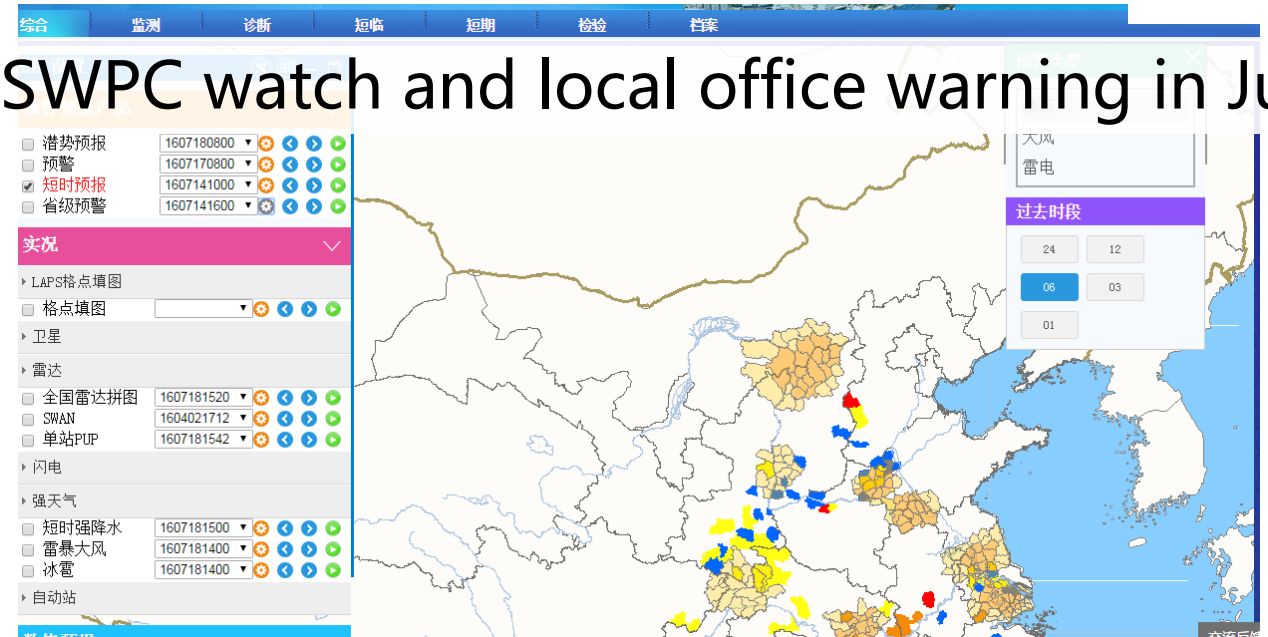


极端强对流活动可能性预报

强对流 天气类型	>50mm/h 强降水	>80mm/h 强降水	>10 级 雷暴大风	>12 级 雷暴大风 或龙卷	>20mm 冰雹	>50mm 冰雹
可能性 （很低、低、中、高）	中	低	中	低	低	很低

*注：此表格内容对分类强对流落区预报进行补充

SWPC watch and local office warning in Jul.14 2016



Time-lagged hourly QPF ensemble prediction Based on GRAPES-RAFS

SWPS 0-12h prediction techniques

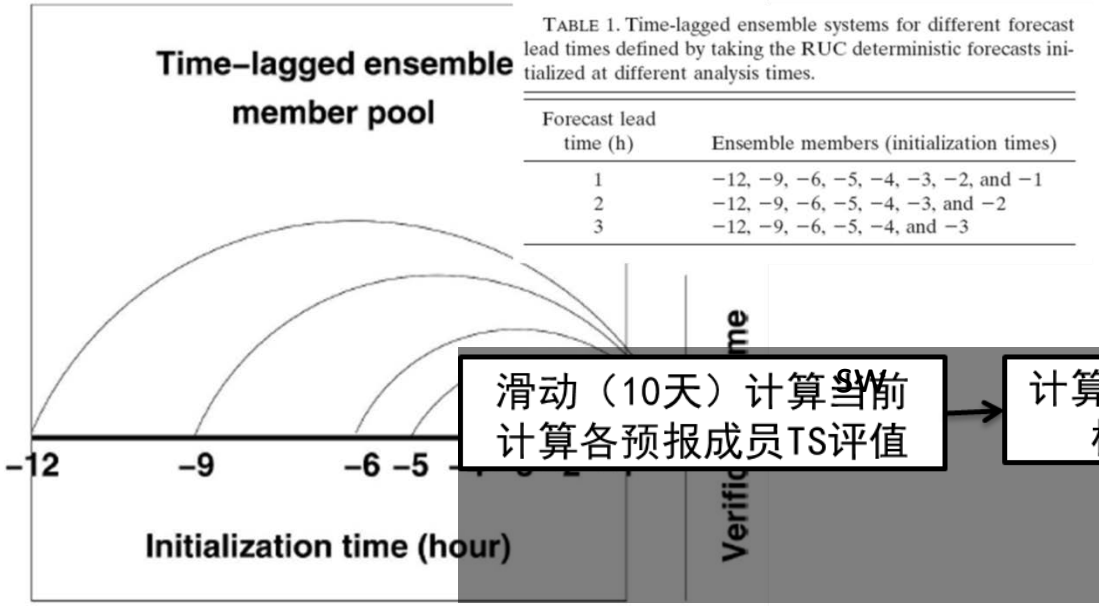


TABLE 1. Time-lagged ensemble systems for different forecast lead times defined by taking the RUC deterministic forecasts initialized at different analysis times.

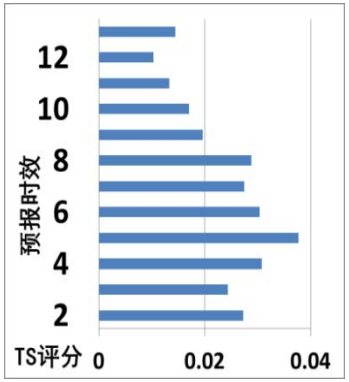
Forecast lead time (h)	Ensemble members (initialization times)
1	−12, −9, −6, −5, −4, −3, −2, and −1
2	−12, −9, −6, −5, −4, −3, and −2
3	−12, −9, −6, −5, −4, and −3

FIG. 3. Schematic diagram showing how a time-lagged ensemble forecast system is constructed.

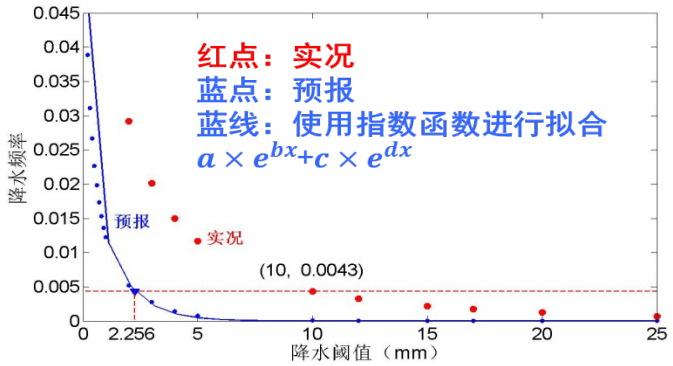
滑动（10天）计算当前
计算各预报成员TS评值

计算各预报成员
权重系数

进入预报方程计算强
降水预报概率值



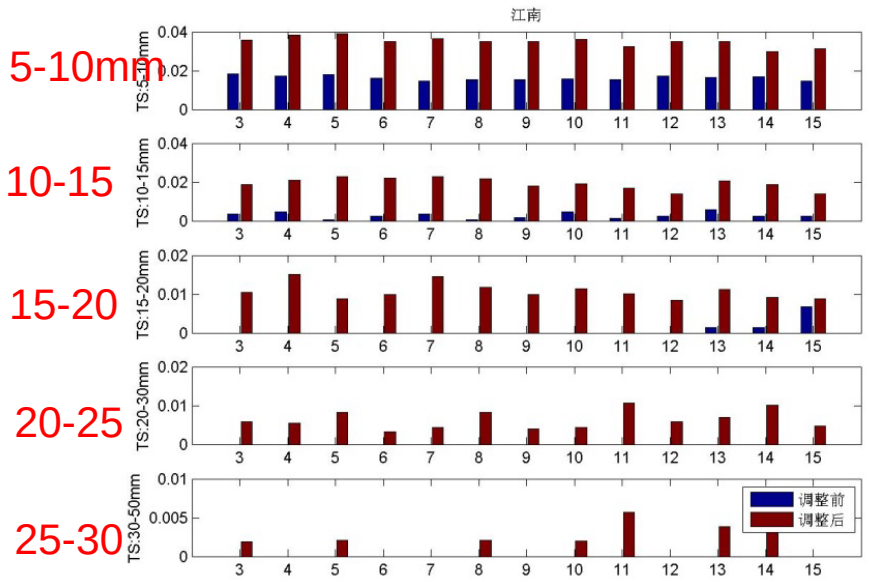
①Weight decided by T Scores

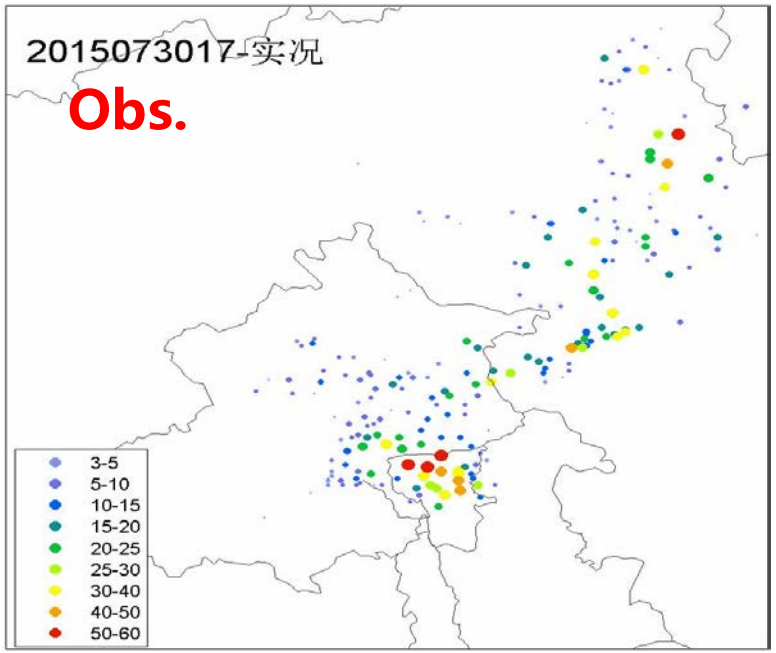


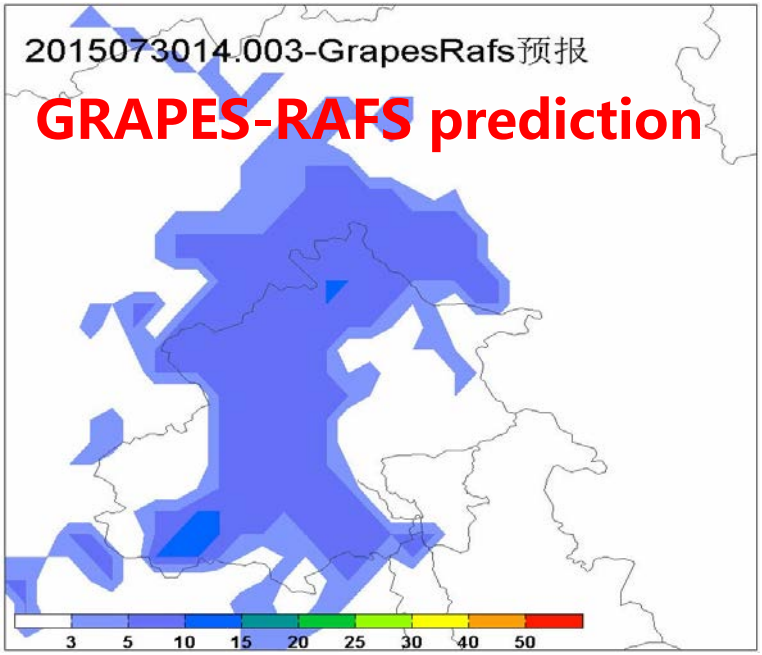
②intensity correction by frequency matching

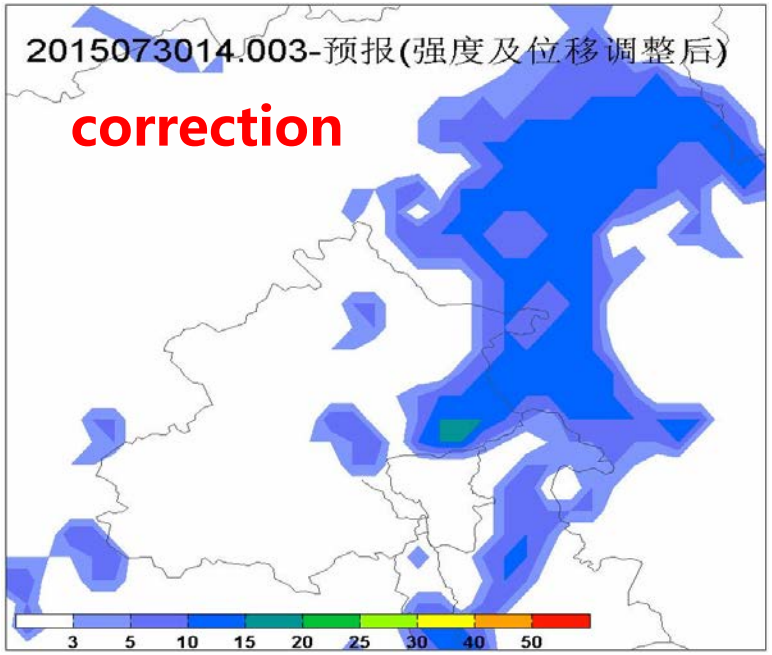
QPF TS in June to August 2015

(red: after, blue: before)





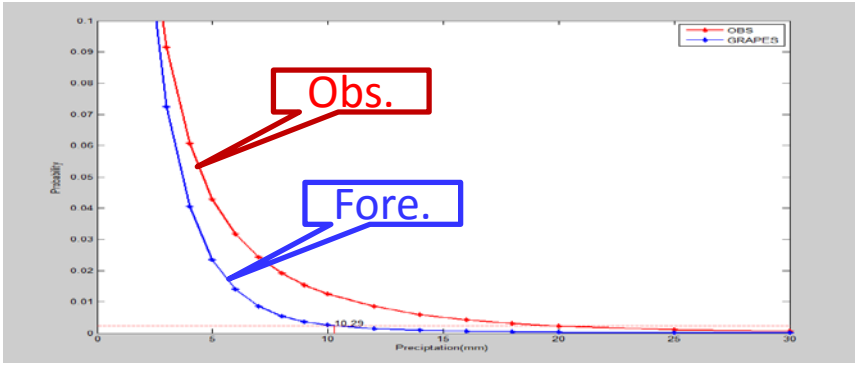




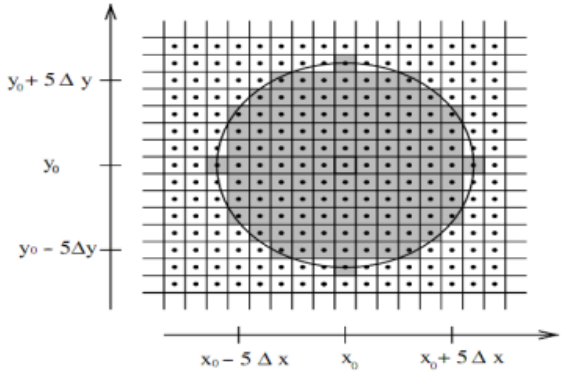
Neighborhood calibration of the short-time rainstorm and strong echo forecast (Upscaling)

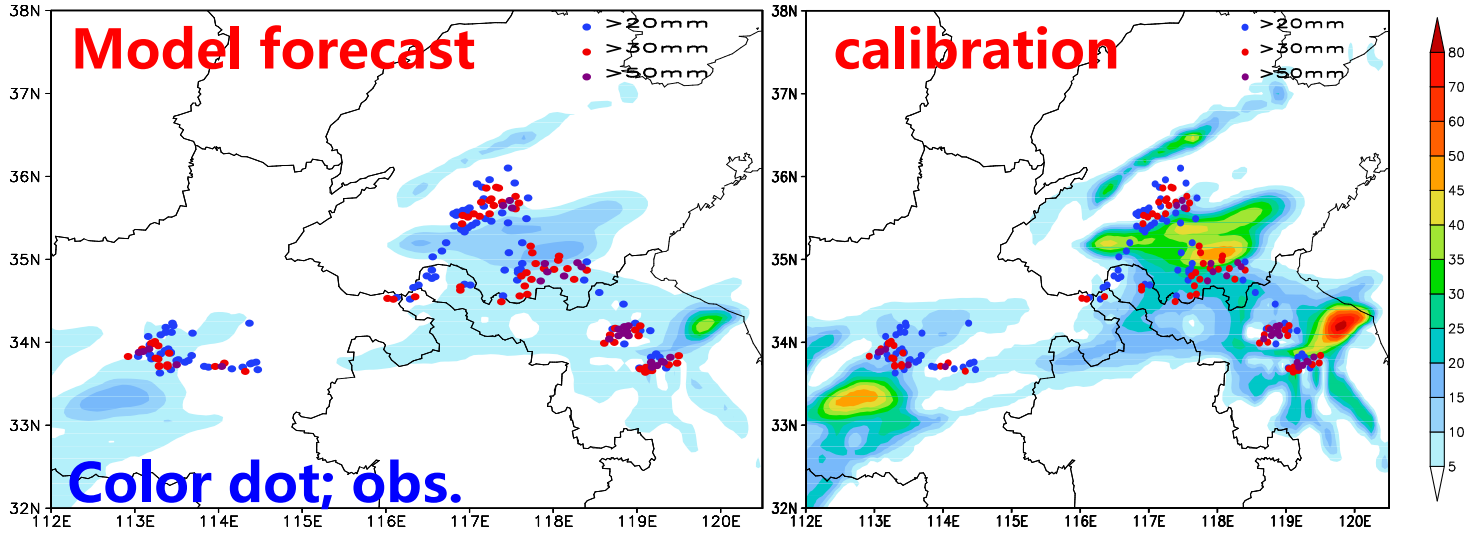
SWPS 0-12h prediction techniques

Fist： intensity correction by frequency matching， Finding the probability forecast threshold of ST rainstorm events (≥20mm/h)



Second： Averaged the space and temporal grids





Super ensemble based on the deterministic HR models

SWPS 0-12h prediction techniques

Models：GRAPES-RAFS and GRAPES-CR from NPC/CMA，WRF from Shanghai bureau, Beijing Bureau and Nanjing University, GRAPES-MESO from Guangdong

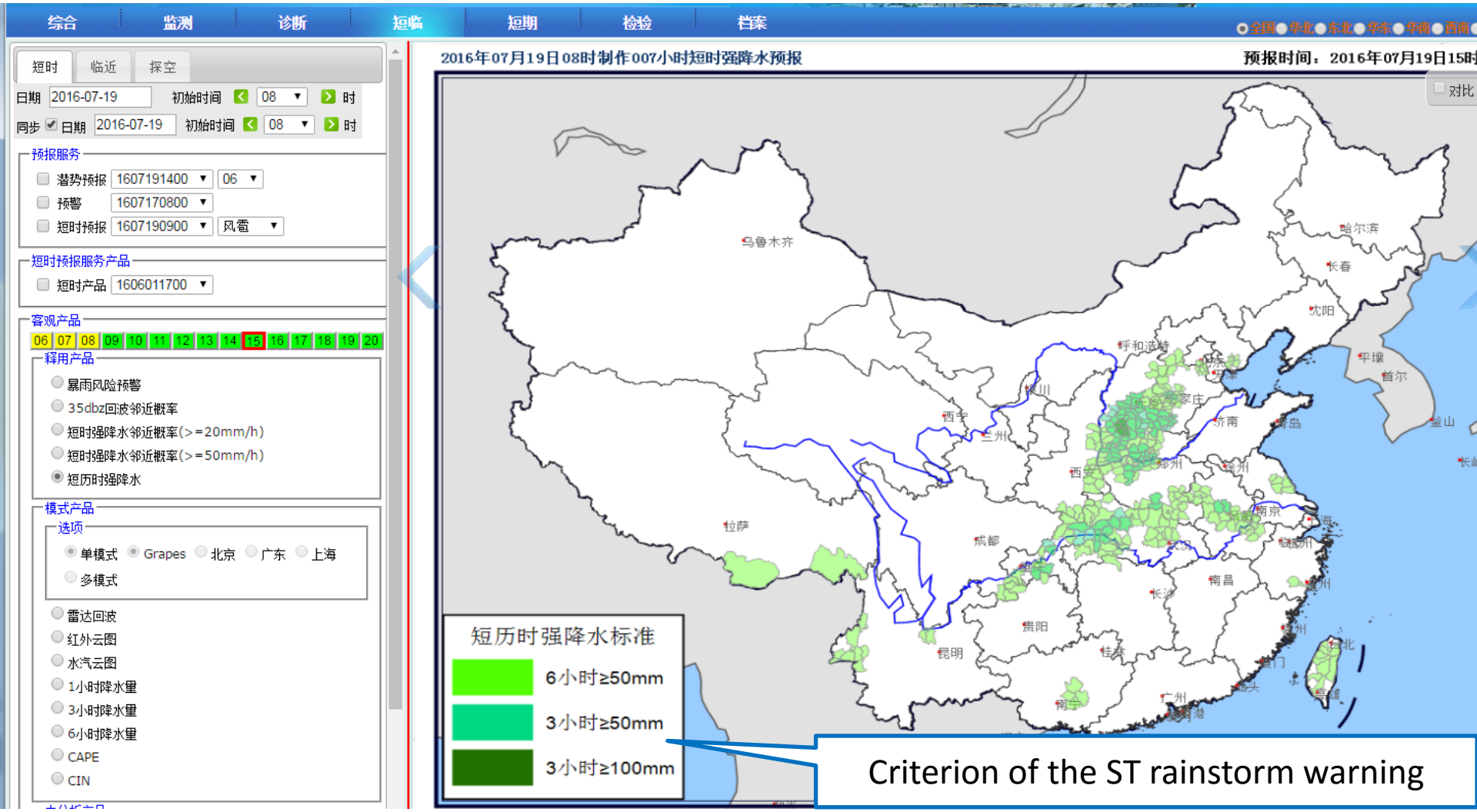
First：Uniform resolution and interpolate to 0.05x0.05 1h

Second：intensity correction by frequency matching and 5-days sliding correction

Third：various weighting for the six models

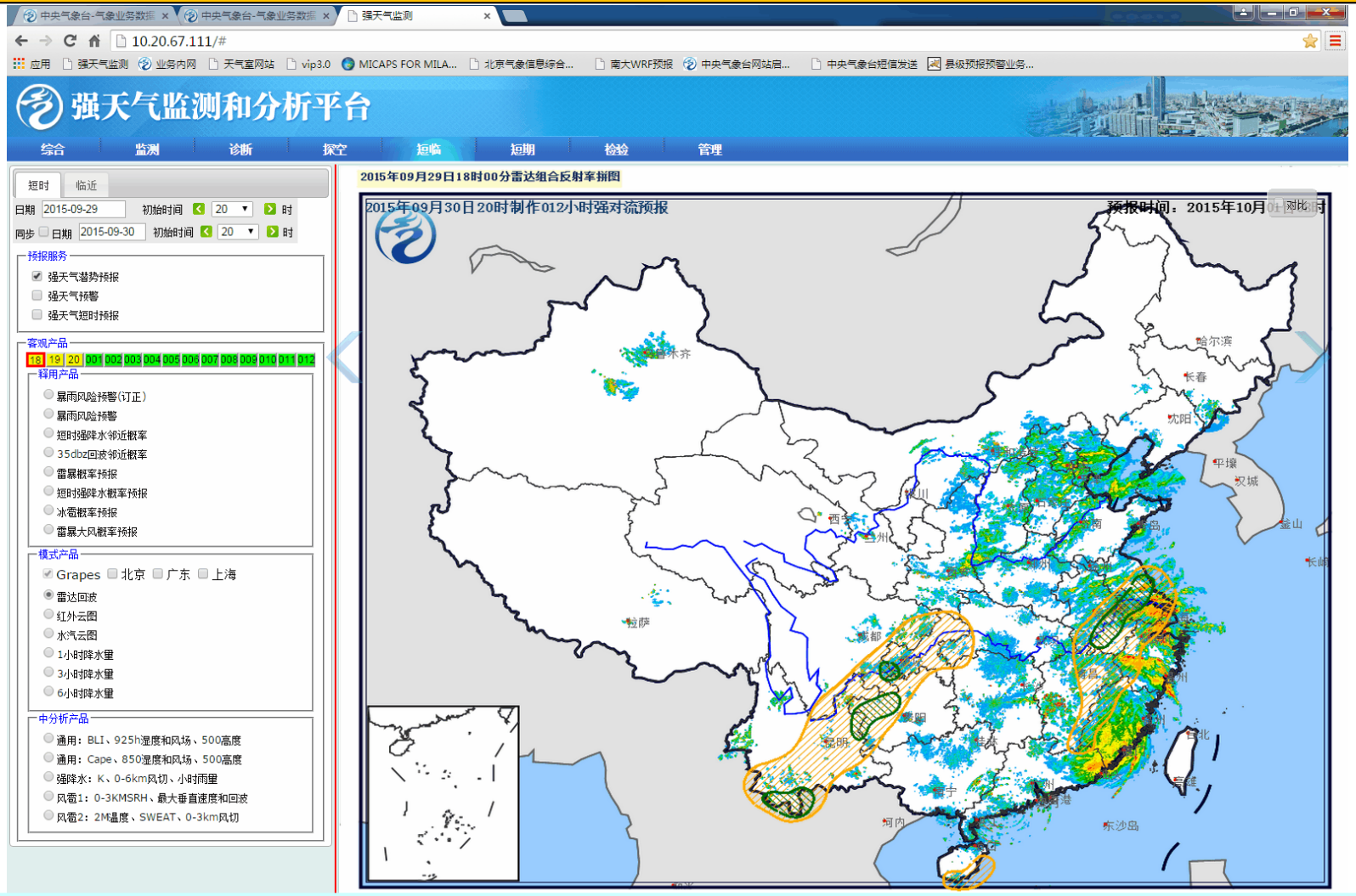
Output：

- 1/3/6h accumulated QPF every 3h
- Every 3h updating ST rainstorm events prediction during 0-12h



Super ensemble ST rainstorm forecast has been integrated in SWPC operational platform

From past to future， Efforts to achieve seamless monitoring and forecasting



-2-12h SCW monitoring and VSR forecasting based on Obs. and high resolution and rapid updating models in SWPC/NMC

Contents

- Severe convective weather characteristics and its operational forecasting in CMA
- 0-2h Nowcasting
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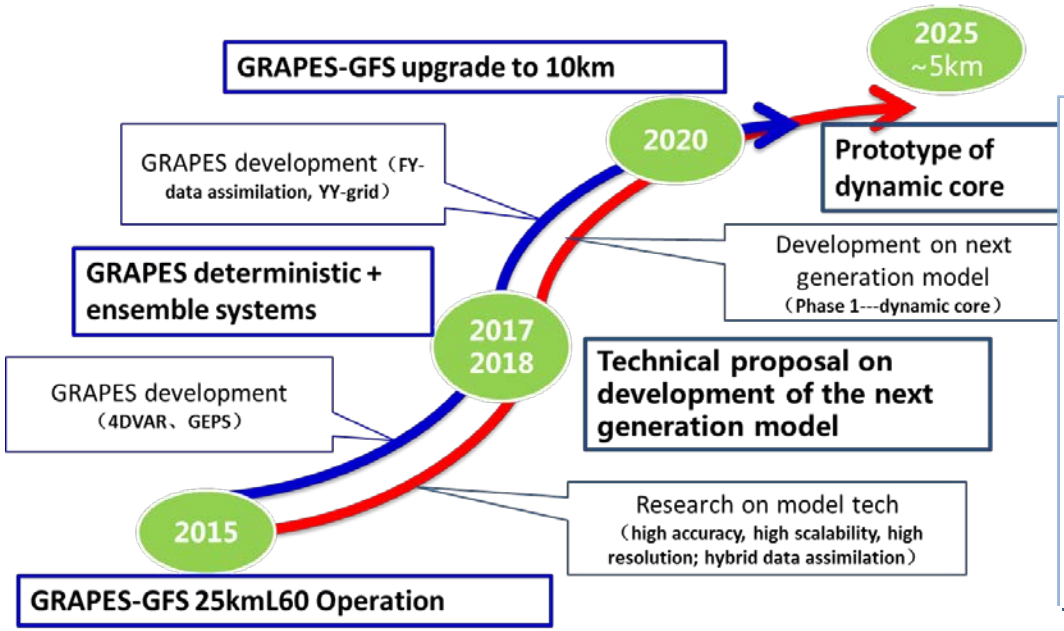
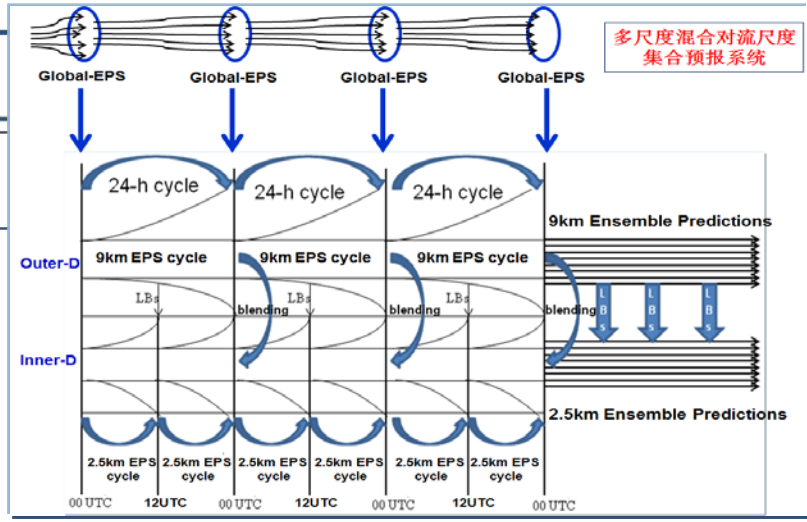
Challenges for nowcasting and VSR forecasting

- How to comprehensively use the multiple data source (radar, satellite, lightning, AWS, NWP outputs and so on)to enhance the extrapolating capability and extend the valid time of forecast
- How to resolve the convective initiation
- How to extend the valid warning time by optimizing the operational process and cooperating between SWPC and the local offices

Roadmap of NWP development for 2015-2025





- **CR EPS**
- **Focus on convective initiation, location and intensity of the high wind and heavy rainfall, large scale forcing and so on**

NWP plays the key and irreplaceable role

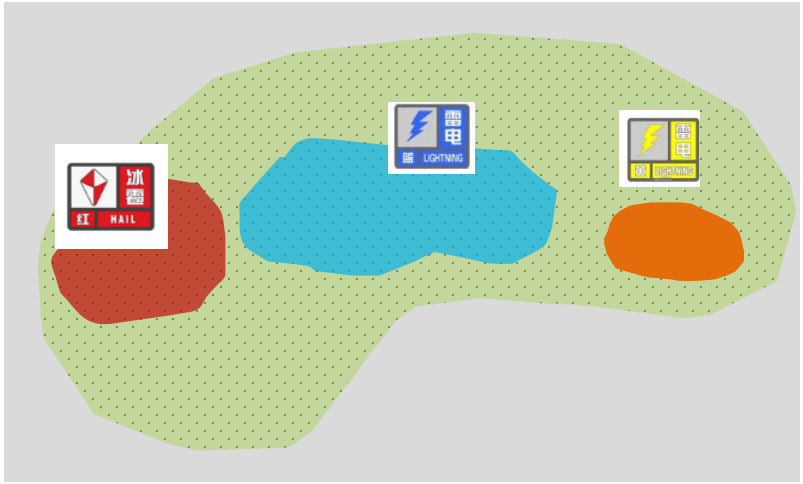
SWPC operational targets to 2018

- To issue the 0-12h objective SCW products with 1h resolution
- To issue the 2-6h subjective watch products to guide local office warning
- To effort the seamless forecasting in 3days by cooperation between SWPC and local offices

2016： products communication between SWPC and local office

SWPC

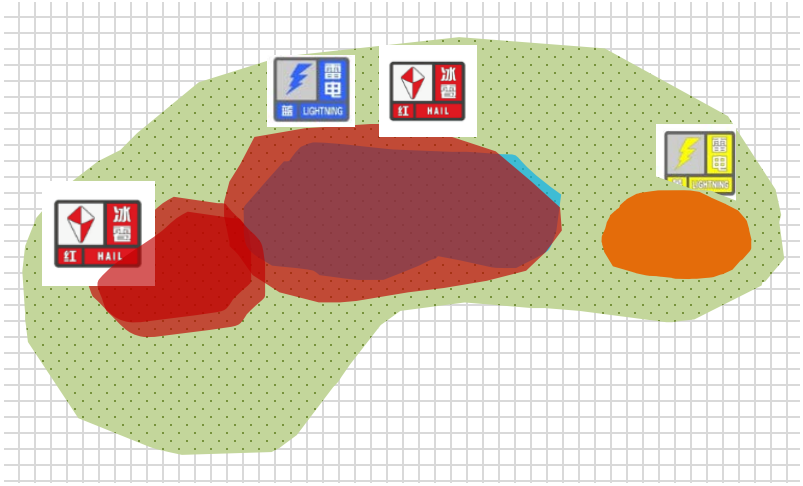
2-6h watch



Local offices： **0-2h warning**

2018： products inter-work

SWPC



Local office

data exchange

Techniques developing plan

Assimilation of multiple data, especialy radar and satellite data

Comprehensive monitor

HR obs. Data applied into convective analysis

Blending, integrated extrapolation algorithms based on radar, satellite dat and so on

Convection monitor and multiple data blending and analysis techniques

Convective-scale analysis techniques

Multiple data comprehensively nowcasting

VSR Forecast techniques based on HR models

Cooperation between the operational branches and the research units

Ensemble ,Upscaling

Warn-on Forecast: to apply the convective recognition and track techniques into the HR models output

- New data and comprehensively monitor and analysis techniques
- Comprehensively extrapolation techniques
- HR models output

- Techniques enhanced further
- Pre-warning techniques of convection initiation,deveoping and decay

- To buid a SCW monitoring, nowcasting and VSR forecasting systems

Thank you

NATIONAL METEOROLOGICAL
CENTER OF CMA